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A Systematic Revision of the Neotropical Species of *Cinnamomum* Schaeffer (Lauraceae)

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Abstract

The Lauraceae are one of the principal tree components of tropical forests. Some species of the genus *Cinnamomum* are important tree elements of tropical forests, but despite this, the American taxa have not been revised taxonomically since the end of last century. This study has the aim of reviewing the American members of the genus, which have mostly been included in the genus *Phoebe*. The taxonomical revision of the species will also address three main questions: 1) do all the American species formerly included in *Phoebe* belong in *Cinnamomum*?, 2) are the triplinerved and pinninerved species of this group of American species congeneric?, and 3) what are the phylogenetic relationships among these species? The revision involved the evaluation of critical taxonomical literature, the survey of herbarium specimens (vegetative and reproductive morphology), field work, and the analysis of leaf anatomical features. These data were used for delimitation of taxa, their description, and preparation of keys for identification.

Forty-seven species were accepted in *Cinnamomum* for the Neotropics, and thirteen species are proposed as new. During the development of this revision, as a result of the study of specimens morphologically related to *Cinnamomum* I described a new genus (*Mocinnodaphne*). By floral morphology, this genus is related to *Licaria*, but presents several vegetative and fruit characters found in *Cinnamomum*.

Evaluation of *Cinnamomum* as a distinct evolutionary line in the Lauraceae, as well as the phylogenetic relationships among the neotropical species and with other taxa within the family was assessed through cladistic analyses. Results suggest that: 1) the syndrome of characters commonly used to distinguish *Cinnamomum* (namely hermaphrodite flowers with nine fertile

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stamens, well developed staminodes, cupule present in the fruit, and tepals mostly persistent in the fruit), although help to recognize the genus as a distinct taxon in the Lauraceae, do not represent apomorphies in this clade; 2) the combination of characters that shape the concept of *Cinnamomum* are applicable to many species formerly included in *Phoebe* in the Neotropics, and they should be placed in that genus; 3) pinninerved and triplinerved species can be considered congeneric, although some morphological data (such as correlation of domatia with other vegetative features) suggest that the two groups may be unrelated; 4) accepting the group of New World species of *Cinnamomum* as monophyletic, there is no indication of identifiable subordinate taxa (sections or subgenera). Principal morphological characters, such as leaf venation pattern, presence of domatia, and number of sporangia in the anthers of whorl III, do not define main subdivisions within this group of species; rather the distribution of these characters suggests that they have evolved in parallel fashion several times within the group.

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Introduction

The Lauraceae, one of eight families in the order Laurales of the Magnoliidae (sensu Cronquist, 1988), comprises around 2000-2500 species in about 50 genera distributed mainly in tropical and subtropical regions of the world (Cronquist, 1981; Rohwer, 1993a). Several species of this family are important constituents of the tall and diverse tropical forests worldwide. Sometimes they are so abundant as to give specific names to the forest, for example, the "Bosque de lauráceas" in the eastern slope of the Sierra Madre Oriental in Mexico (Sarukhán, 1968). They play also an important role as one of the main food sources for several species of birds in tropical forests (Wheelwright, 1983, 1986; Wheelwright et al., 1984). Furthermore, some species of Lauraceae are sources of commercial timber, fruits, chemical compounds and spices (Kostermans, 1957; Gottlieb, 1972; Record & Hess, 1942; Stern, 1954). Examples include ironwood, avocado, camphor and cinnamon, all widely used today.

The family has a long and well documented history in the botanical literature (Kostermans, 1952). However, despite the work done to date, the taxonomy of the Lauraceae is still, in several cases, not sufficiently clear in terms of the circumscription of taxa at the genus or species level. As a result, the reputation of the family as being taxonomically difficult is still valid (Burger, 1988; Rohwer et al., 1991). One of the cornerstones in the study of the Lauraceae is the work of Meissner (1864), the last botanist who revised the entire family and established the basis for its classification. More recently, Kostermans (1957, 1968, 1969, 1970, 1986, 1988) had undertaken the job of revising the classification of the Lauraceae. He reassessed the importance of characters to distinguish subordinate taxa within the family, proposed a new classification scheme, and at the same time started monographic work in several genera.

There have been several attempts to record and describe the diversity of the Lauraceae in Latin America, particularly through local floras. For example, Standley (1922, 1946) studied the species in Mexico and Guatemala, Allen (1948) in Panama, Macbride (1938) in Peru, Bernardi (1962) in Venezuela, Kostermans (1939) in Chile, Roig & Acuña (1949) in Cuba, and Burger & van der Werff (1990) in Costa Rica. Other works have been made with a broader regional perspective, including that of Allen (1945), who surveyed the Mexican and Central American species, and the important one by Mez (1889) for all the Latin American species.

Floristic studies, as they are surveys concerned with recognition (listing) and identification of taxa in a particular area, usually do not consider the whole range of variation recorded for the different taxa in order to delimit and subdivide them. Systematic revisions are the kind of studies that deal with classification questions of a given group. This kind of research work is concerned with all the available information about the biology of the group of species under study in order to define, as clear as possible, the natural limits of the taxa, where they occur, the variation of their characteristics, and the evolutionary relationships within the group and to other groups.

There are now several examples of systematic revisions for genera of Lauraceae in Latin America: Kostermans (1936, 1937) for *Licaria*; (1937) for *Endlicheria*, *Cryptocarya*; (1938a) for *Aiouea*, *Urbanodendron*, *Systemonodaphne*, *Mezilaurus*; (1938b) for *Beilschmiedia* and *Aniba*; Kopp (1966) for *Persea*; Kubitzki & Renner (1982) for *Aniba* and *Aiouea*; Kurz (1983) for *Licaria*; van der Werff (1987a) for *Mezilaurus*; (1993) for *Pleurothyrium*; Rohwer (1988) for *Dicypellium*, *Phyllostemonodaphne*, *Systemonodaphne* and *Urbanodendron*, and (1993b) for *Nectandra*.

Twenty-nine genera of Lauraceae have been recorded in America (van der Werff, 1991) and, as can be seen from the revisions mentioned above, much work remains. Although some genera are currently being revised, several need attention to clarify their limits, subdivision and relationships. One of these genera is *Cinnamomum*, the subject of this research project, which contains several species that are important elements in the submontane forests of the Neotropics.

The recognition of *Cinnamomum* in the Neotropics

Whether *Cinnamomum* should be recognized in the New World or not has been in dispute for almost forty years (Kostermans, 1952; 1957; 1961). The difficult taxonomy of the Lauraceae has had much to do with the present state of confusion about the distribution of that genus, and the lack of uniform taxonomical criteria to deal with the species, has precluded the solution of the problem. Next I explain several aspects of the problem and the objective of my study.

Genera in the Lauraceae are recognized on the basis of combinations of characters that intergrade among these taxa occasionally. Floral and fruiting characters have been mostly used to circumscribe taxa at the genus level, for instance, how many and which stamen whorls are fertile, number of sporangia in the anthers, extent of development of staminodia in the fourth whorl of the androecium, and extent of hypanthium development in the fruit. Relationships among genera have also been inferred on the basis of those characters.

General morphological features of *Cinnamomum*, namely, triplinerved or pinninerved leaves, cymose-paniculate inflorescences, flowers with three whorls of fertile stamens (mostly with four sporangia) of which the innermost is extrorse, staminodes of the fourth whorl present and well developed, and fruits seated on a cupule (mostly with tepals persistent), are shared with

several genera. These features mainly indicate the implicit relationship of *Cinnamomum* to other genera as presented in the classification schemes of the Lauraceae. This relationship has changed as genera are relocated according to each authority's opinion in what is the hierarchy of the significance of characters in elucidating groups below the family level (Table 1). Thus, Nees (1836) considered that (what is called today[Rohwer, 1993a]) *Cinnamomum* could be divided into two different monotypic tribes: Cinnamomeae, and Camphoreae. Meissner (1864) thought *Cinnamomum* was related to *Persea* and allied genera, and later Bentham (1880) and Pax (1889), with some differences, added to that group the genus *Ocotea* and related genera. Kostermans (1957) excluded *Persea* and its allied genera, but included others like *Umbellularia* and *Actinodaphne* (currently in a different subfamily) as relatives in the tribe where *Cinnamomum* was placed. More recently, Hutchinson (1964) placed *Cinnamomum* together with *Persea* and *Ocotea* and their allies, along with genera like *Caryodaphnopsis, Hypodaphnis* and *Eusideroxylon*, which are morphologically distant from *Cinnamomum*. In the last general account on the classification of the family (Rohwer, 1993a), *Cinnamomum* is placed with *Aiouea*, *Endlicheria* and *Neocinnamomum*, along with *Ocotea* and related genera. For most of the classification systems produced so far, *Phoebe* has been put in the same group as *Cinnamomum*, with which it shares the same floral morphology, except for the hypanthium that is short and it does not develop into a cupule in the fruit. Instead, in this genus the imbricate bases of persistent indurate tepals make a cup supporting the fruit.

Cinnamomum was first recognized for the New World by Kostermans (1961); formerly, the neotropical species were treated as part of *Phoebe* (Nees, 1836; Meissner, 1864; Mez, 1889; Allen, 1945; Hutchinson, 1964), a genus considered by Kostermans (1961) as restricted to the

Nees (1836)	Meissner (1864)	Bentham (1880)	Pax (1889)	Kostermans (1957)	Hutchinson (1964)	Rohwer (1993a)
Subdivided in two tribes, one genus each: *Cinnamomum*, and *Camphora*.	*Alseodaphne*, *Cinnamomum*, *Nothaphoebe*, *Persea*, *Phoebe*.	*Cinnamomum*, *Dicypellium*, *Nectandra*, *Ocotea*, *Persea*, *Pleurothyrium*.	*Cinnamomum*, *Dicypellium*, *Nectandra*, *Nothaphoebe*, *Ocotea*, *Persea*, *Phoebe*, *Pleurothyrium*, *Umbellularia*.	*Actinodaphne*, *Cinnamomum*, *Dicypellium*, *Ocotea*, *Sassafras*, *Umbellularia*.	*Caryodaphnopsis*, *Cinnamomum*, *Dicypellium*, *Eusideroxylon*, *Hypodaphnis*, *Nectandra*, *Nothaphoebe*, *Ocotea*, *Persea*, *Phoebe*, *Pleurothyrium*.	*Aiouea*, *Cinnamomum*, *Endlicheria*, *Nectandra*, *Neocinnamomum*, *Ocotea*, *Pleurothyrium*, *Rhodostemonoda-phne*.

Table 1. Genera with which *Cinnamomum* has been placed in different classification systems.

Malaysian region. Originally *Phoebe* was described containing two groups of species (Nees, 1836); one Asiatic with species where the leaves are pinninerved and the fruit is without a cupule and seated on the clasping indurate persistent tepals, and an American group where the leaves are frequently triplinerved and the fruit is sustained by a mostly thickened pedicel, and the floral tube develops into a shallow cupule which usually has on its rim the persistent tepals. The two groups were later treated as sections by Meissner (1864), the Cinnamomoideae and the Perseoideae, for the American and Asiatic species respectively. Bentham (1880) included *Phoebe* in *Persea* maintaining the two sections as Gnesiopersea and Phoebe. Finally, Pax (1889) again recognized *Phoebe* with two sections. *Cinnamomum* on the other hand, was always considered an Asiatic genus with two sections since Meissner's (1864) work, Camphora, with leaves mostly pinninerved and alternate, and Malabathrum, with mostly triplinerved and opposite to subopposite leaves (hereinafter section Malabathrum is called section Cinnamomum, since it contains the type species of the genus [Greuter et al., 1994: article 22]). Fruit characters in *Cinnamomum* are as in many of the formerly considered American species of *Phoebe*; i.e. a berry seated on a cupule which bears the whole or partially persistent tepals on its rim.

As suggested in the section name used by Meissner (1864) for the American species of *Phoebe*, most of them closely match the morphology of the fruits and leaves of the genus *Cinnamomum*, and already in the early fifties Kostermans (1952) supported the idea of reducing *Phoebe* to include just the Asiatic species, and placing the American species in another genus. Initially he thought some species should be moved to *Persea* and the rest to *Cinnamomum* (Kostermans, 1957), but later, anticipating a revision of the group, he transferred all the American species of *Phoebe* to *Cinnamomum* (Kostermans 1961, 1988). Nees (1836) recognized

6 species of *Phoebe* in the Neotropics, Meissner (1864) recorded 14 species, and by the end of the nineteenth century Mez (1889) accepted 45 species. Kostermans accepted 87 species, which he transferred to *Cinnamomum*, and about 15 more specific names have since been published (e.g., Vattimo, 1962, 1977, 1984; van der Werff, 1987b, 1988, 1991b). As several species were first described without information about the fruit, and floral characters had not been critically revised in the whole group, the little more than one hundred names currently in use were undoubtedly an overestimation of the actual number of species. Since presence of particular features is no guarantee for the correct placement of a taxon in the classification system, the group of American species formerly recognized in *Phoebe* needed to be thoroughly surveyed in order to define which of them really go under the genus *Cinnamomum*, and to find out if *Phoebe* is indeed absent in the Neotropics. Therefore, a critical survey of herbarium specimens, along with selected and suitable observations and collecting in the field, would result in a better estimate of the number of taxa, possibly fewer than 60 (van der Werff, 1991a).

It is pertinent to mention that some botanists currently consider in *Cinnamomum* only those species (formerly in *Phoebe*) that have triplinerved leaves (Vattimo, 1962). At the same time, some American species of *Phoebe* with pinninerved leaves whose floral features do not fit *Cinnamomum* characters have been already removed to other genera (Rohwer, 1986, 1991).

Another problem I will examine here is the relationship of the American species to the two sections recognized for the genus in the Old World tropics. While in *Phoebe*, the species studied here were placed in two subgenera, Heteranthera and Euphoebe (Mez, 1889), based on the number of cells found in the stamens of the third whorl, however, as mentioned before, the sections Cinnamomum and Camphora are based on different (combinations of) characters

(Meissner, 1864) that are not present in the American species. Therefore, based solely on the character of venation pattern, it is not clear whether the American species with pinninerved leaves and those with triplinerved leaves are related correspondingly to the sections of *Cinnamomum* in the Old World. In other words, are the American species of *Cinnamomum* with pinninerved leaves closer to section Camphora?, and do the species with triplinerved leaves belong to the same evolutionary line that represents section Cinnamomum?

To date, placing of the studied species in *Phoebe* or *Cinnamomum* has generally been derived from the survey of regional floras, but no attempt has been advanced to study the whole group of taxa at once. This is my purpose here, since this is the best way to solve general problems in systematics. Thus, the main questions addressed here are: 1) do the American species formerly included in *Phoebe* belong in *Cinnamomum*?, 2) are the triplinerved and pinninerved species of the group to be studied congeneric?, and 3) what are the phylogenetic relationships among these species?

Procedures

I. Taxonomic revision. Loans of *Phoebe* and *Cinnamomum* specimens from the Neotropics, including the nomenclatural types for the species currently or formerly included in these genera, were requested from the principal herbaria in the United States (A, F, GH, LL, MICH, NY, US), Europe (B, BM, BR, C, G, K, P, S, U, W) and Latin America (ENCB, MEXU, R, RB, SP, VEN). Several herbaria (BHCB, ENCB, F, HB, HXBH, IAN, IBGE, IEB, MBM, MEXU, MG, MY, NY, R, RB, SP, SPF, SPSF, UB, UEC, VEN) were visited to find additional specimens of the subject species by looking at holdings of related genera and unidentified

material.

Five trips abroad for collecting additional material were carried out. Trips ranged from 30-45 days and were accomplished as follows: two visits to southern Mexico, one during the Summer of 1992, and another one in the Spring of 1993; one visit to Venezuela in the Summer of 1993; two visits to Brazil, one to the southeastern region in the Fall of 1993, one to the central and southern regions in the Winter of 1994-1995. In this way I observed several species alive, recorded critical data (missing data for some species, like vegetation type where they grow, size, and habit), and fixed samples for anatomical studies. A total of 14 species of *Cinnamomum* were collected in the field. In addition, 96 collection numbers corresponding to several genera in the Lauraceae were gathered. A set of the collections is to be filed at the Facultad de Ciencias herbarium (FCME), at the Universidad Nacional Autónoma de México, another one at the Missouri Botanical Garden herbarium (MO); duplicate surplus will be distributed to other herbaria.

The first step to decide which taxa would be included in the study was to set a workable combination of characters against which nomenclatural types would be judged to separate the species belonging to *Cinnamomum*. To do this, I applied previously and generally accepted concepts of the genera *Cinnamomum* and *Phoebe* (Kostermans, 1957; Rohwer, 1993) in a survey of the morphological characters in the holdings from Asia for these two genera at MO. The aim of this survey was to find out how consistent the combination of diagnostic characters was in both genera, in order to reach a decision on the boundaries of confidence when applying these concepts to the species under study. Attribution of all nomenclatural types to either *Phoebe*, *Cinnamomum* or any other genus in the Lauraceae was determined checking their vegetative,

floral (by dissection when flowers present) and fruit characters. This work yielded a preliminary list of accepted names in *Cinnamomum* and other genera. This survey also constituted a first approach to evaluate those characters that might be useful later in defining the species.

The rest of the exsiccatae were studied morphologically and arranged in sets of specimens with similar characters to be matched later with types and named. The study of sets of specimens with similar morphology served simultaneously various other purposes: 1) to distinguish the species and define how distinct they are, 2) to evaluate how variable species are in their features, 3) to find out if the different species had several names (synonyms), 4) to detect correlation of morphological variability with ecological or geographical aspects, and 5) to determine which taxa still need more field work to get additional material for their study, and cover missing characters, morphological variation, or possible spurious gaps in their geographical range.

Species delimitation was based on consistency of combination of characters. In other words, species' diagnostic characters were evaluated for extent of correlation among them, and extent of overlapp with other species' characters. Important vegetative features in species recognition were type of hairs of the indument, leaf venation pattern, presence and characteristics of domatia, and leaf shape. Salient reproductive characters were external pubescence of tepals, hypanthium pubescence, presence and position of abscission lines in tepals, persistence of tepals in fruit, and extent of distal swelling of pedicel.

Descriptions were prepared once species were delimited. For each species the same information from vegetative (stem features, leaf size, shape and venation pattern, pubescence, and presence of domatia) and reproductive (inflorescence type, perianth features, morphology of androecium and gynoecium, and morphology of fruit) characters were recorded with the aim of

producing parallel and comparable descriptions. All measurements given in the descriptions for vegetative and fruit characters were obtained directly from dried material; flowers were rehydrated for the study, and measurements for their structures come from this "fresh" condition. Description format for the new species (which includes Latin diagnoses) is different from that of already published and accepted species, because it follows Novon's journal directions to facilitate their recovery for publication. Species' descriptions furnished the base for the construction of a dichotomous key for all the accepted taxa.

A database in Microsoft Access was made for collector's name and number, locality, habitat, collection date, herbarium, and other standard information, from exsiccatae as a way to organize and retrieve information to add at the end of species descriptions. Distribution maps of species were made using this database.

To complement morphological information, I also made a general survey of the leaf anatomy in most of the studied species. This work was centered on the analysis of tissue system distribution in the mesophyll. Cross sections of leaves from fixed (in FAA) and rehydrated material (overnight in a weak solution of commercial detergent, washed, and then for 10 h in a 5% ammonium hydroxide solution at 60°C) were made by hand and surveyed under light microscope to record characters and their variation among species. Leaf sections including midvein area at the level of domatia, intercostal area, and leaf margin were made and mounted in a solution of calcium chloride.

II. Phylogenetic analysis. Conclusions from the morphological studies regarding the *Cinnamomum* genus concept, as well as the inclusion of species in this genus, were tested by a cladistic analysis of the genera contained in the Lauraceae, and a cladistic analysis of the

neotropical species in *Cinnamomum* using PAUP 3.1 (Swofford, 1990). Reconstructions of some characters were visualized using MacClade 3.0 (Maddison & Maddison, 1992). In this way the hypothesized position of the studied species to *Cinnamomum*, relationships of the pinninerved and triplinerved species, and species evolutionary connections were evaluated. Character state conditions were determined by outgroup analysis (Watrous & Wheeler, 1981; Maddison et al., 1984; Stuessey & Crisci, 1984). A more detailed explanation of the methods followed for this work is presented in the section dealing with the phylogenetic aspects of this study.

Results

I. Taxonomic revision

General

After analyzing the morphological characters in Asian species of *Phoebe* and *Cinnamomum*, I reached the following conclusions:

1. None of the species in the New World previously ascribed to *Phoebe* belongs to this genus. The survey of morphology shows that true *Phoebe* species are characterized by a combination of traits not found in any of the neotropical species. First, *Phoebe* species lack a hypanthium, or if it is present it is very short, and, no cupule is developed with the maturation of the fruit. Second, tepals are entirely persistent but with their bases tightly overlapping and clasping the base of the fruit. Third, leaves are always pinninerved and without domatia. Fourth, fruit pedicel is never distally swollen. The set of characters observed in *Phoebe* species seems to apply to a group of species placed in *Persea* in the Neotropics, however, as relationships between *Persea* and *Phoebe* are poorly understood, it requires further study to conclude if *Phoebe* is

indeed restricted to the Old World.

2. Many of the neotropical species heretofore considered to belong in *Phoebe* are closely related, morphologically, to the Asian species of *Cinnamomum*, and it is better to place them in this genus. The Asian and American species of *Cinnamomum* share the following combination of characters: first, there is a hypanthium that usually broadens with the developing fruit forming a cupule. Second, tepals are persistent at the rim of the cupule, but they are rather spread out and do not overlap at their bases. Third, leaves are mostly triplinerved or subtriplinerved, and domatia are frequently present. Fourth, the fruit pedicel is commonly swollen and turbinate.

3. The New World species of *Cinnamomum* differ from the Asian ones in that they present a mixture of the characters found in the sections recognized for the genus in the Old World. While section Camphora is distinguished by having perulate buds, alternate leaves, usually subtriplinerved to pinninerved, and with domatia, section Cinnamomum is separated by the absence of perulate buds, presence of opposite leaves, always triplinerved, and without domatia; but the neotropical species are always with alternate leaves, and when domatia are present they occur in triplinerved leaves not in pinninerved ones (except one species). A summary of diagnostic characters in *Phoebe,* the two sections of *Cinnamomum* in the Old World, and the two groups of neotropical species is presented in Table 2.

4. Several species from the Neotropics formerly included in *Phoebe* belong to other genera, mostly to the genus *Ocotea* (see section on excluded species below).

The concept of the genus *Cinnamomum* I applied in this study, and which forms the basis for the inclusion of a given species in this genus, encompass the following set of characters:

- Flowers perfect with three whorls of fertile stamens.

- Tepals erect at anthesis.

- Staminodia of the fourth whorl present, having a distinct filament and a well developed sagittate or triangular head.

- Tepals either complete or partially persistent in fruit; their bases not strongly imbricate and clasping the base of the fruit.

- Hypanthium distinct, shallow, not accrescent in fruit but forming a conspicuous cupule.

- Fruit pedicel distally swollen, turbinate.

Leaf venation pattern and presence of domatia were not taken as critical features to incorporate neotropical species in *Cinnamomum*, because these characters vary among the Old World species of the genus. Thus, I included a species in the genus regardless of the condition of these traits, and later I assessed their relevance on the relationships among the neotropical species, and the relationship between these ones and the Old World species. Therefore, initially, pinninerved and triplinerved species were considered congeneric. The validity of this preliminary assertion is tested afterwards in the phylogeny section.

I also included those species which presented tepals entirely deciduous soon after anthesis as the only exception of the *Cinnamomum* character syndrome, for it seemed an extreme of variation in tepal persistence and a possible trend of evolution within the genus. Besides, the absence of tepals in the fruit of these species might be useful to evaluate the likelihood of parallel evolution for this trait among genera related to *Cinnamomum*, such as *Ocotea* and *Persea*.

Next, the conspectus for the neotropical species recognized in *Cinnamomum* followed by the taxonomic treatment is presented.

			---------- *Cinnamomum* ----------		
	Phoebe	**Camphora**	**Cinnamomum**	**Neotrop 1**	**Neotrop 2**
Phyllotaxy	alternate	alternate	opposite	alternate	alternate
Shoot buds	not perulate	perulate	not perulate	not perulate	not perulate
Domatia	absent	present	absent	mostly present	absent
Venation pattern	pinninerved	mostly pinninerved	mostly triplinerved	mostly triplinerved	pinninerved
Flower sex	hermaphrodite	hermaphrodite	hermaphrodite	hermaphrodite	hermaphrodite
Fertile stamens	nine	nine	nine	nine	nine
Staminodia	well developed	well developed	well developed	well developed	well developed
Cupule in fruit	not present	present	present	present	present
Tepals in fruit	persistent	not or partially persistent	at least partially persistent	entirely persistent to deciduous	entirely persistent to deciduous
Pedicel in fruit	not turbinate	turbinate	turbinate	turbinate	turbinate

Table 2. Comparative relation of diagnostic characters of the genera *Phoebe* and *Cinnamomum* sections Camphora, Cinnamomum, and the two groups of species from the neotropics.

Vegetative Morphology.

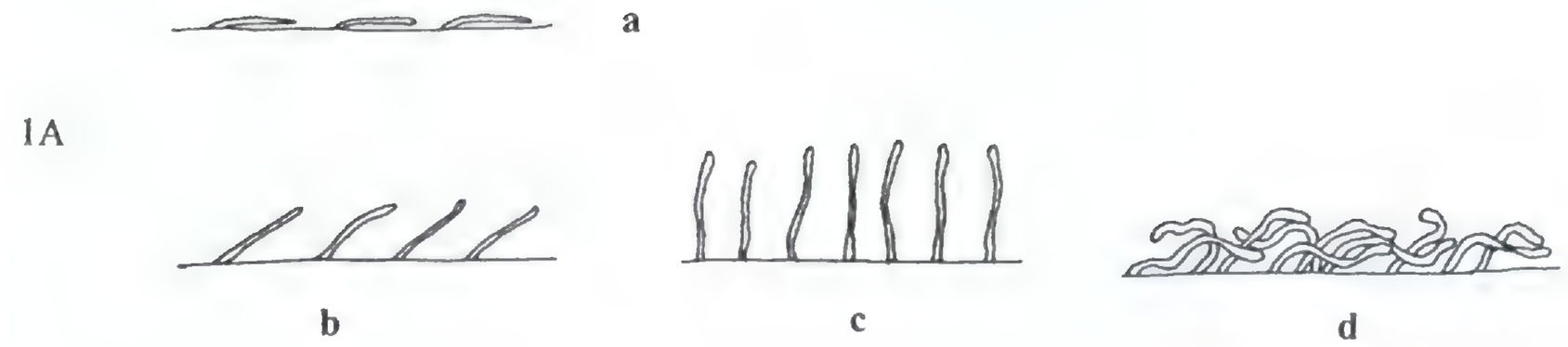
The tree habit is the most characteristic growth form among neotropical species of *Cinnamomum*. Large trees (up to 30 m tall), for example those of the species *C. breedlovei*, *C. costaricanum*, *C. effusum*, *C. padiforme*, *C. pseudoglaziovii*, and *C. triplinerve*, tend to be associated with mesic climatic conditions, like those found at middle elevations along mountain ranges from southern Mexico to the Andes in Bolivia, and along eastern mountains in Brazil. Small trees and shrubs are more characteristic in hotter and/or drier conditions; that is the case for instance of *C. haussknechtii*, *C. salicifolium*, *C. quadrangulum*, *C. uninervium*, and *C. velvetii*. Bark is usually smooth and light colored, brown, reddish brown to grayish brown or gray, but very often is covered by lichens that camouflage the original surface of the trunk. Twigs commonly are terete and more or less pubescent, but there are few examples where young branches are winged or totally glabrous. Hollow twigs have been recorded in a couple of species (*C. napoense* and *C. formicarium*). Shoot buds are not perulated.

Leaves are alternate; occasionally subopposite leaves are found in some specimens but this condition is never consistent enough to distinguish any species. Petiole is invariably present, though sometimes very short, mostly channeled adaxially, rounded abaxially. Leaf shapes and sizes do not span a wide range; ovate and elliptic shapes and medium size (5 - 15 cm long) constitute the general condition for these features. A remarkable exception is *C. formicarium* with leaves up to 60 cm long and 30 cm wide. Blade margin is always entire, though sometimes slightly revolute. Venation pattern also varies little, most species have triplinerved to subtriplinerved leaves (figures 1, 6, 13), while just some species are rather strictly pinninerved (figures 1, 9, 11, 17), for example *C. amplexicaule*, *C. chiapense*, *C. chavarrianum*, *C.*

erythropus, and *C. napoense*. Midvein and secondary veins usually look different on upper and lower leaf surfaces, being rather flat to slightly sunken above and slightly raised to strongly raised below. Tertiary and minor venation is commonly not raised, but it is distinct. Upper and lower leaf surfaces very often also differ in color, deposition of wax and pubescence. In general, lower surface is lighter in color, sometimes glaucous due to the presence of wax, and retains longer the original condition of pubescence found in young leaves.

Pubescence is an important character for distinguishing species of *Cinnamomum* in the Neotropics. The indument often varies in density between younger and older parts of the plant and among individuals of the same species; but the most important features are hair form and orientation. Although hairs are always simple, they vary from straight to curly, and from strictly appressed to erect (figure 1). The fact that hair type is rather constant for a given species strengthens the point of considering this character useful for taxonomical purposes. There are some cases where a combination of hair types occurs, but these cases are uncommon. Hair color is not considered important, but there is a type of trichomes present in several species that is quite distinct in structure and also color; these hairs are dark red, usually wavy, and rather thick walled and stiff. When present they occur on one or more of the following structures: along veins on upper and lower leaf surfaces, on margins of leaf bud bracts, and along twigs in linear pattern.

Domatia on lower leaf surfaces are common, and their morphology is also an important character for distinguishing species. Domatia are taken here as specialized areas of varying form located at the axils of secondary and also tertiary veins on the abaxial surface of the leaf (Wilkinson, 1979; O'Dowd & Willson, 1989). Form of domatia in angiosperms vary, with a continuum of types, from simple tufts of hairs to pouches or pockets. In *Cinnamomum* domatia



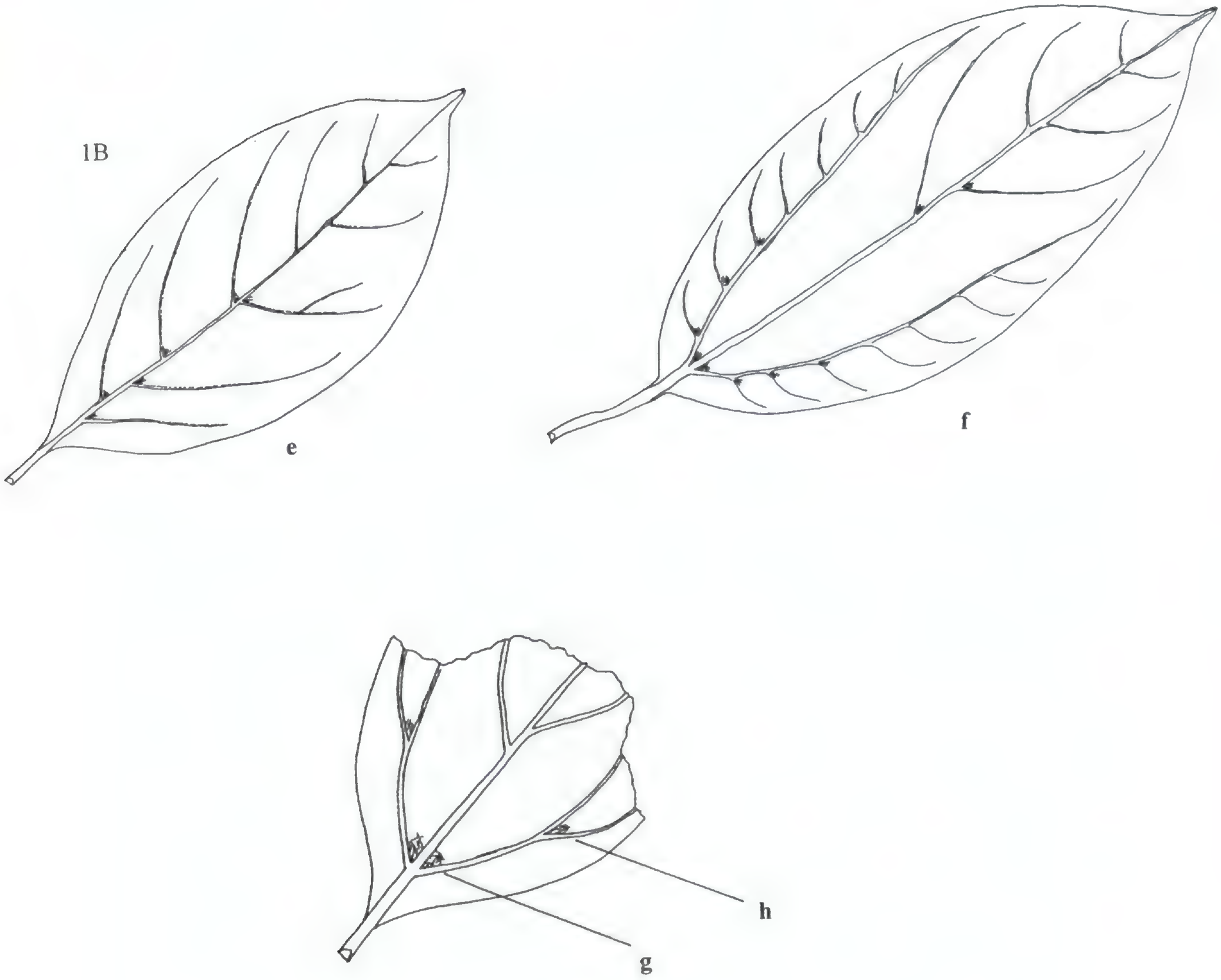


Figure 1. Vegetative characters of *Cinnamomum*. 1A: Schematic view of hair types in neotropical species of *Cinnamomum*; **a**, hairs straight and appressed; **b**, hairs straight and spreading; **c**, hairs straight and erect; **d**, hairs wavy to curly. 1B: Leaf venation pattern and domatia in neotropical species of *Cinnamomum*; **e**, pinninerved leaf with primary domatia; **f**, triplinerved leaf with primary and secondary domatia; **g**, primary domatium; **h**, secondary domatium.

are primarily of two types: 1.) dense tufts of hairs, and 2.) flat to concave elliptic to circular areas, glabrous or with hairs mainly on the borders. In this study a primary domatium is defined as the one present along the midvein in the axils of secondary veins (figure 1). The term secondary domatium is applied to that one present along secondary veins in the axils of tertiary veins (figure 1). There are several species of *Cinnamomum* in the neotropics that do not have domatia at all. About a third of the species studied here only have primary domatia (usually 1 - 3 pairs), and almost the same proportion of species present both primary and secondary domatia. Appearance of domatia varies in pubescence (glabrous to densely hairy), and other features. When present, hairs in domatia often contrast sharply with those occuring on the lower leaf surface; they can be erect and wavy or parallel to leaf surface, straight and stiff, or sometimes, they are just longer than the rest of hairs on lower surface. Leaf area of domatia varies from flat (most species) to deeply concave on lower surface, and from flat to ampullous on upper surface. Sometimes the lower domatia surface is slightly shiny, as if there were some secretion on it, but it is difficult to assert the glandular condition of this tissue. Actually, so far there is no anatomical evidence of specialized cells either in the epidermis or mesophyll of domatia (Wilkinson, 1979), including those of some Lauraceae (O'Dowd & Willson, 1989). Several kind of animals, mostly mites, in different life stages (and some plants !) were found in the domatia of most species, yet it is not easy to say whether these organisms spend their whole life there, or use these leaf areas occasionally as shelters of some sort.

Reproductive Morphology.

Inflorescences are determinate, mostly thyrses (figures 6, 13, 17), often the last dichasia

lack distinct peduncles and they appear congested (glomerulate) (figure 11); less common is the condition where lateral branches of the inflorescence are reduced to single flowers and then the inflorescences look like racemes. In a few species inflorescences are made of only one to three dichasia and are strictly paniculate (figure 9). Small bracteoles at the base of inflorescence branches are always present but they wither and fall very soon; several species however, present conspicuous foliose bracts at the base of some secondary branches, sometimes as large as normal leaves. These foliose bracts are also commonly deciduous, but occasionally they persist until fruits are mature. The usual position of inflorescences is axillary to leaves (figures 6, 13, 17), but often they are axillary to small bracts that fall off soon before anthesis, appearing terminal on foliose shoots, or borne on very short vegetative branches axillary to leaves and appearing clustered at leaf axils (figure 11), or finally, they can be produced at the base of new shoots, in the axils of small bracts that are shed early in shoot developement..

Flowers are small and bisexual, urceolate or narrow campanulate, with six erect, usually concave, tepals. Fertile stamens are nine, with glands at the base of the innermost three, and the staminodes of fourth whorl are well differentiated in a distinct filament and a triangular to cordate head (figure 2). The hypanthium is also distinct. As a rule, tepals are about the same size, but there are some species where the three outer ones are slightly smaller than the inner ones. The two whorls are sericeous on the inner surface (figure 2); only rarely are the external tepals glabrous. Pubescence on outer tepal surface is variable; commonly it is glabrous, and in a few species it is densely hairy, puberulous, tomentose or hirsute. Stamens are about the same size, but the three innermost very often have rather quadrangular anthers and their filaments are shorter than the anthers, while the two outer whorls have elliptic to ovate compressed anthers that are

rather longer than their filaments (figure 2). Number of sporangia is typically four in all the anthers, but there are several species where a trend to or actual suppression of upper sporangia of third whorl of stamens is present (figure 2). Staminodes are always smaller than stamens, their heads usually longer than their filaments. Very often the adaxial face of the staminode head appears wet or sticky, suggesting the secretion of some substances and the glandular condition of this tissue. The hypanthium seems to be receptacular in origin, as the shifted acropetal position of perianth elements, stamens and staminodes suggest. Pubescence of stamens, staminodes and inner surface of hypanthium is mostly sericeous, but sometimes, particularly on filaments or anthers can be sericeo-pilose. Frequently characteristic hairs are found scattered or concentrated and abundant on some parts of flowers (both surfaces of tepals, third whorl stamens, inner surface of hypanthium); these hairs are deep red in color, with thick walls and stiff appearence. They seem to be of the same nature as those hairs mentioned above that occur on young branches and leaves. Pistil is invariably glabrous, with the ovary mostly shorter than the style. There was no evidence of distylous plants in the studied species.

Fruits are drupes, seated on the broadened (not conspicuously enlarged) hypanthium which in turn usually bears at its rim the (whole or partially) persistent tepals (figure 2). Fruit pedicel (flower pedicel) is always, at least distally, swollen and turbinate, and continuous with the hypanthium (figure 2); less frequently it is conspicuously elongated. Thickening of pedicel is a useful character to separate several species. In some taxa the pedicel is conspicuously swollen just distally, the proximal section of it remaining cylindrical (yet thicker). On the other hand, there are other species where the whole pedicel is evidently swollen and evenly turbinate from top to bottom, leaving no part of the pedicel identifiable as such a structure. Tepals commonly

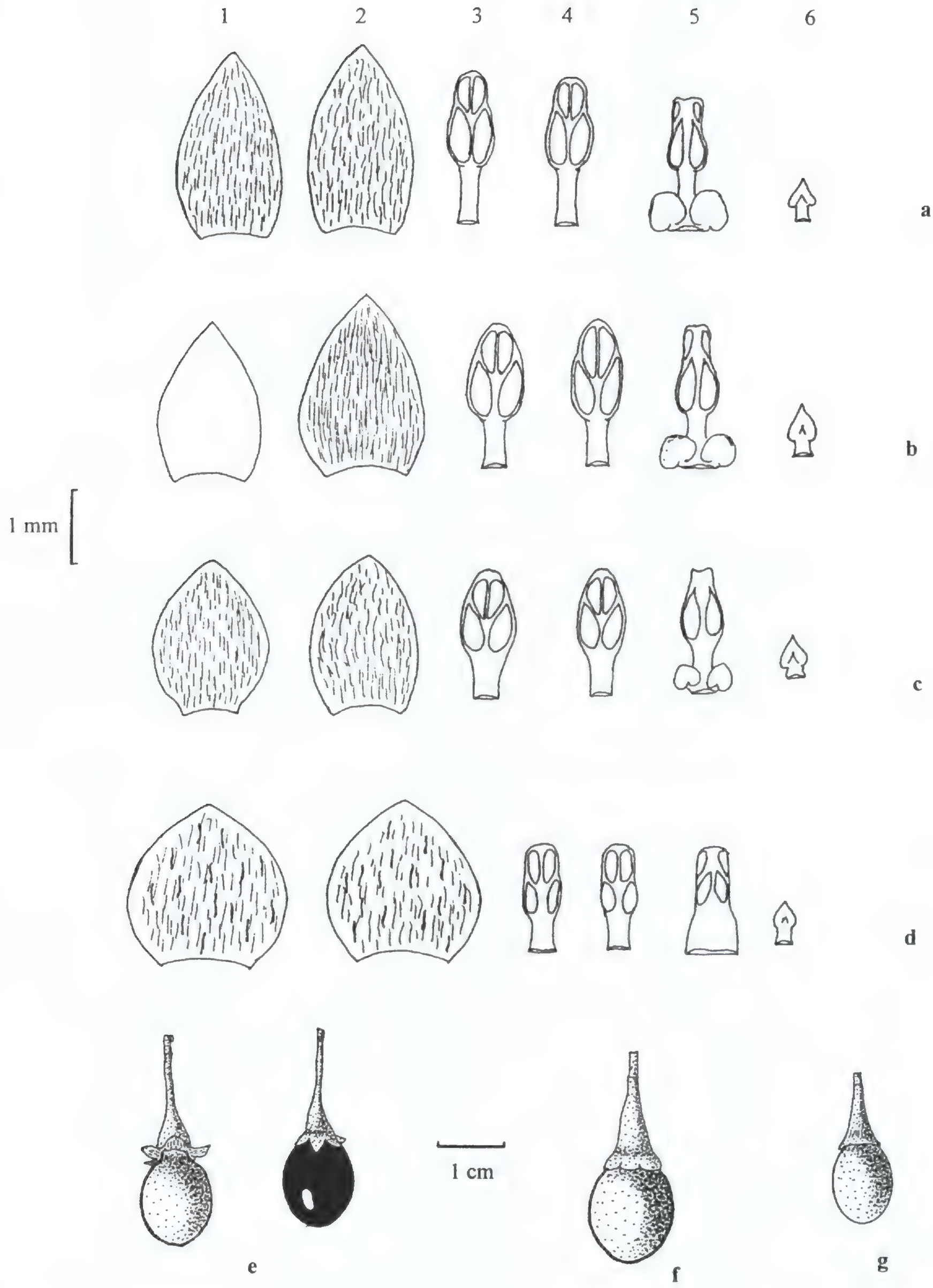


Figure 2. Floral and fruit morphology in neotropical species of *Cinnamomum*. Floral parts: 1. adaxial view of external tepal; 2. adaxial view of inner tepal; 3. adaxial view of a stamen from whorl I; 4. adaxial view of a stamen of whorl II; 5. abaxial view of a stamen of whorl III; 6. staminode. **a**, dissected flower of *C. triplinerve*; **b**, dissected flower of *C. chavarriana*; **c**, dissected flower of *C. napoense*; **d**, dissected flower of *C. concinnum*; **e**, fruits with entire persistent tepals of *C. salicifolium*; **f**, fruit with partially persistent tepals of *C. neurophyllum*; **g**, fruit with deciduous tepals of *C. alainii*.

are not conspicuously enlarged, but they may be sometimes a little bit stiffer or thicker than they were in the flower. As mentioned before, usually they are persistent, although sometimes partially so by the abscission of part of them right after anthesis by individual lines above their bases. In some species the abscission line is below the tepal base and connected to the next one, making a continuous line through which all six tepals are separated as one piece right after anthesis. While pedicel, hypanthium, and tepals tend to turn red or reddish as fruit matures, ripe berries are dark green or almost black in color.

Anatomy.

Reference to the anatomical features of the wood in several species of *Cinnamomum* can be found in the surveys accomplished by Stern (1954) and Richter (1981). Vessels range from ca. 160-665μ in length, with simple and scalariform perforations. Wood fibers are septate in some cases. Although in general the wood morphology is similar among the Asian and the Neotropical species, bark characters lead to the recognition of three distinct groups (Richter, 1981), one of them the New World species.

Early in this century Petzold (1907) published a study of the anatomical features of leaves in the American species of Lauraceae. He did not find clear correlation of characters to distinguish genera one from each other, although there were some combinations of traits that characterized certain genera. As for *Cinnamomum*, my survey of 32 of the 47 neotropical species confirms the general findings by Petzold, and adds a few more remarks on the variation of particular anatomical features of the leaves in this genus.

All neotropical species of *Cinnamomum* studied have dorsiventral, hypostomatic leaves,

with palisade chlorenchyma toward the adaxial surface (figure 3). Cuticule commonly is rather thin, particularly on lower leaf surface, but there are some cases where it is up to 3 times the thickness of the epidermal cells on the upper surface (*C. haussknechtii*, *C. sellowianum*, *C. taubertianum*, *C. uninervium* (figure 3), *C. velvetii*). Some species have the lower surface conspicuously papillose by thumb-like outgrowings from individual epidermal cells (*C. chavarrianum*, *C. triplinerve*); some others are minutely papillose (*C. amoenum*, *C. stenophyllum*, *C. zapatae*). Upper epidermis is mostly made of a single cell in thickness, but some species are with 2 discontinuous layers of cells, and then with oblique walls (*C. chavarrianum*, *C. costaricanum* (figure 3), *C. neurophyllum*). Stomata are, in the few species studied, of the anomocytic type. Hairs are invariably unicellular, with rather thick walls; in some species hair lumen is almost absent by secundary growth of cell walls. Hypoderm under the adaxial surface was found only in one species (*C. formicarium*), consisting of 2 to 3 layers of cells; this character is reported for the first time in *Cinnamomum*. The number of palisade layers varies from 1 to 4 in the species studied (one layer: *C. ampullaceum*, *C. areolatum*, *C. breedlovei* (figure 3), *C. chiapense*, *C. hirsutum*, *C. leptophyllum*, *C. napoense*, *C. neurophyllum*; two layers: *C. bractefoliaceum*, *C. costaricanum* (figure 3), *C. effusum*, *C. glossophyllum*, *C. grisebachii*, *C. hartmanii*, *C. hatschbachii*, *C. haussknechtii*, *C. longipes*, *C. pachypodum*, *C. padiforme*, *C. quadrangulum*, *C. salicifolium*, *C. sellowianum*, *C. stenophyllum*, *C. taubertianum*, *C. triplinerve*, *C. uninervium* (figure 3), *C. velvetii*, *C. zapatae*; three layers: *C. amoenum*, *C. chavarrianum*, *C. formicarium*, *C. salicifolium*, *C. zapatae*; four layers: *C. formicarium*). Usually lower layers are narrower than upper ones, and sometimes rather loose. Petzold's observation on distinguishing compact from loose palisade chlorenchyma was not

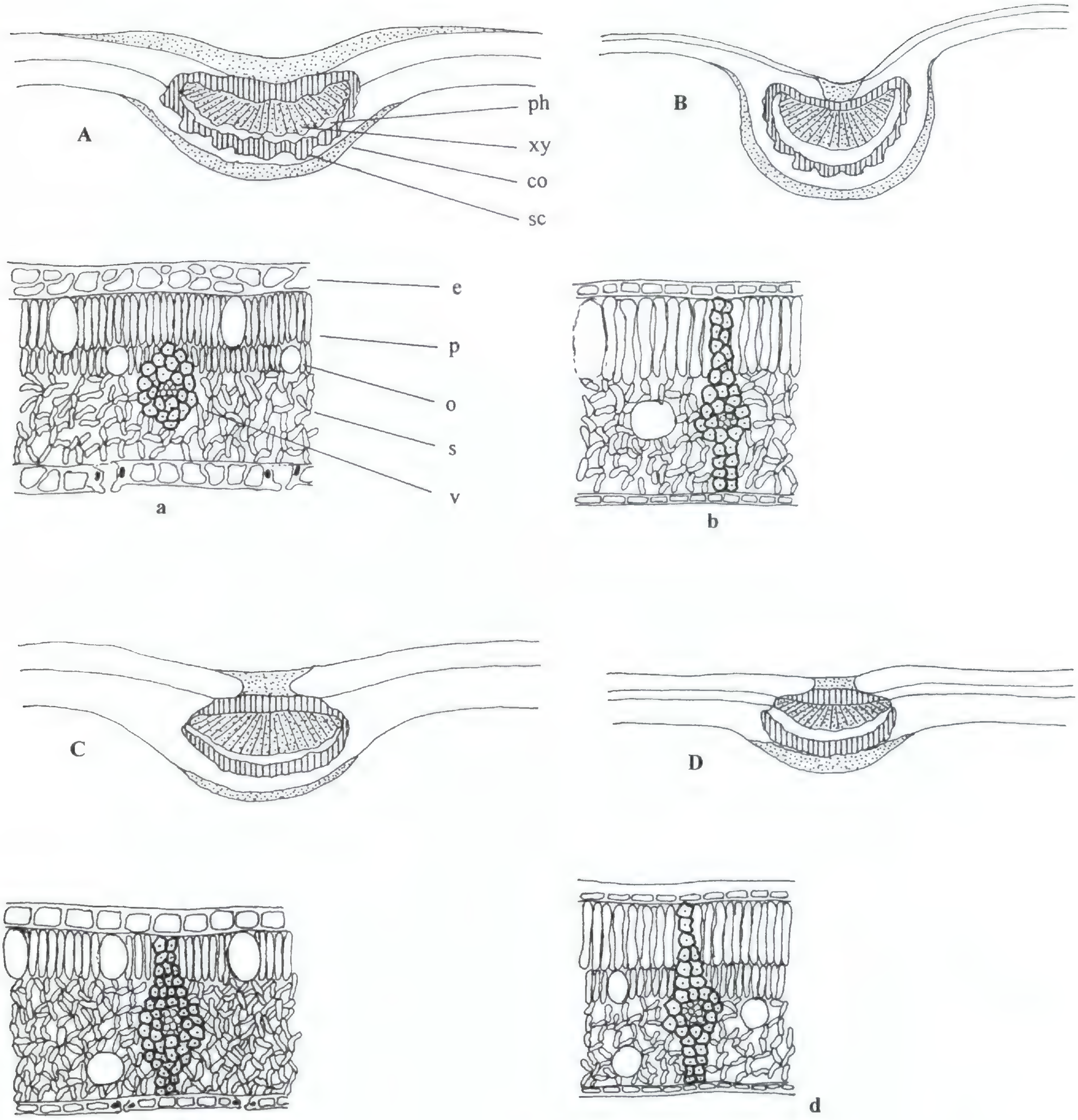


Figure 3. Schematic views of variation in leaf anatomy of neotropical *Cinnamomum*. **A**, Cross section of *C. costaricanum* at midvein; **a**, same species, leaf blade section. **B**, Cross section of *C. breedlovei* at midvein; **b**, same species, leaf blade section. **C**, Cross section of *C. leptophyllum* at midvein; **c**, same species, leaf blade section. **D**, Cross section of *C. uninervium* at midvein; **d**, same species, leaf blade section. co= collenchyma, e= epidermis, o= oil cell, p= palisade parenchyma, ph= phloem, s= spongy parenchyma, sc.= sclerenchyma, v= vein surrounded by sclerenchyma, xy= xylem.

apparent in the neotropical species surveyed. Spongy parenchyma varies from compact with small air spaces to loose and containing conspicuous lacunae. Oil cells are usually present, but sometimes scarce. They can be in both palisade and spongy chlorenchyma (figure 3), but few species have them apparently restricted to palisade tissue (*C. formicarium*). Oil cells are commonly ellipsoid, and the same size as surrounding cells when in the palisade layers. When in the spongy chlorenchyma they tend to be spherical and bigger than neighboring cells. Midvein in cross sections show usually the vascular tissue arranged in a slightly crescent arrangement (figure 3); xylem adaxial and phloem abaxial. Few species present a rather flat view of the vascular tissues (*C. bractefoliaceum*, *C. chiapense*, *C. hartmanii*, *C. haussknechtii*, *C. leptophyllum* (figure 3), *C. uninervium* (figure 3), *C. velvetii*). Sclerenchyma normally surrounds the whole vascular bundle, and collenchyma frequently is adjacent to both upper and lower sides of collenchyma. There is only one species (*C. napoense*) where vascular tissue appeared fragmented in several separate bundles in the midvein. Secondary and tertiary veins are mostly with transcurrent sclerenchyma (figure 3); except in *C. costaricanum* (figure 3), and *C. neurophyllum*. View of cross sections at the level of domatia did not show difference compared to that of normal leaf tissue, except for the presence of hairs on the borders and sometimes also on the walls of those structures. It is interesting to note that, when domatia are distinct in pubescent leaves, hairs do not arise from the bottom surface. Contrary to what was found by Petzold (1907), crystals were not seen in any of the species in cross sections, but it might be found that they are conspicuous only in epidermal peelings, which were not prepared for all the species in this study.

When contrasted to what was previously known about the leaf anatomy of some species

of *Cinnamomum*, it turns out that the group of American species are not as uniform as has been claimed for some species in the Old World (Santos, 1930). Characters do vary widely in some cases, as for example, the number of palisade layers.

Cytology.

Chromosome numbers have shown to be rather constant among and within genera in the Lauraceae, including *Cinnamomum* with n=12 being the rule (Ehrendorfer et al., 1968; Mehra & Bawa, 1969; Okada & Tanaka, 1975; Sharma & Bhattacharyya, 1959). To date, only one species of *Cinnamomum*, out of fourteen surveyed, is known to have n=10, the others are with n=12 (Mehra & Bawa, 1969). Polyploid numbers have been reported in *Cassytha* (Okada & Tanaka, 1975), *Laurus*, and *Sassafras* (Ehrendorfer et al., 1968). Basic chromosome number in the family is considered to be x=12 (Ehrendorfer et al., 1968). Few cases of polyploidy are known within the family (Okada & Tanaka, 1975), and it has been suggested that evolution below family level has rather implied changes in chromosome structure and isolating mechanism between species (Mehra & Bawa, 1969). Chromosome morphology is quite homogeneous among the four species of *Cinnamomum* studied in detail (Sharma & Bhattacharyya, 1959); size varies from 0.9 - 3.4μ long, primary constrictions are median to submedian, and secondary constrictions vary from four to eight, subterminal or distal. Until now, however, only Old World species have been studied; no attempt to study the chromosome morphology in neotropical species was made in this study.

Phytochemistry.

In the reviews of Hegnauer (1966) and Gottlieb (1972) at least eleven classes of

secondary metabolites have been identified in the Lauraceae. Although the phytochemical survey of the family is still meager, the distribution of these chemical compounds across the genera suggests some support to Kostermans' classification system based on morphology; for the presence of some chemicals occurs only within the limits of certain tribes and subtribes (Gottlieb, 1972). The Cinnamomeae (sensu Kostermans) are particularly rich in secondary compounds, all the eleven classes of these chemicals have been found at least in one genus of this tribe. One of these chemical classes, the arylpropanoids, are rather restricted to that tribe (except for *Eusideroxylon* in the Cryptocaryeae) and can be a good source of information for systematics. However, as Birch (1963) suggested, the understanding of biosynthetic pathways is crucial, rather than only the record of presence or absence of classes of compounds for the elucidation of evolutionary relationships among taxa. Unfortunately, the pathways of production of arylpropanoids (derived from the amino acid phenylalanine) have several steps that are not fully understood and are still under study (Birch, 1963; Gottlieb, 1972). Beside this problem, although arylpropanoids are well represented in *Cinnamomum*, the amount and type of these metabolites vary widely, even within species (Guenther, 1950; Fujita, 1951 in Birch, 1963); which emphasizes the fact that before using these chemicals as taxonomic markers, it is necessary to make a general survey of their content to understand the source of variation related with type of plant material, stage of growth, and ecological conditions. In spite of these problems, some authors claim to have succeeded in relating the production of certain chemicals and the evolutionary relationships within taxa of the Lauraceae (Gottlieb, 1982; Gottlieb & Kubitzki, 1982), even in *Cinnamomum* (Fujita, 1952; 1960). Originally, a general survey to detect the presence and variation of arylpropanoids in neotropical *Cinnamomum* was considered

in the present study, but given the scarcity of fresh plant material this part of the study was abandoned.

Distribution.

In America, *Cinnamomum* ranges from central Mexico to southern Brazil, Paraguay and northern Argentina (Mez, 1889; Bernardi, 1962), mainly following mountain ranges at middle elevations. Many species are important components of cloud forests, indicating the affinity of the genus to humid places, but there are also some species in relatively dry areas (see section on Vegetative morphology for examples). While 30 species grow in the range of 1000-2000 m, only eight can be found below 500 m, and just three thrive above the 2500 m level (see Table 3). From the known record of species distribution it seems that very few have wide ranges (*C. padiforme*, *C. triplinerve*) and that two main centers of diversity exist, one in southern Mexico - northern Central America (with ca. 17 spp.) and another one in southeastern Brazil (with ca. 15 spp.). In between these extremes, the mountains of Costa Rica and Panama have a secondary area of diversity with ca. 8 spp. *Cinnamomum* is almost absent from the lowlands of the Amazon basin (under 250 m), but it is found at these elevations in the Guyana region and northern Brazil, represented by some populations of the variable *C. triplinerve*.

Reproductive biology.

Observations on the reproductive biology of *Cinnamomum camphora* and *C. zeylanicum* (Kubitzki & Kurz, 1984) suggest that the genus has a dichogamous outbreeding mechanism, as has been found in other species with hermaphrodite flowers in the Lauraceae (Skutch, 1945;

	0 - 250	251 - 500	501 - 750	751 - 1000	1001 - 1250	1251 - 1500	1501 - 1750	1751 - 2000	2001 - 2250	2251 - 2500	2501 - 2750	2751 - 3000
C. alainii				X	X	X						
C. amoenum			X	X	X							
C. amplexicaule			X	X	X		X					
C. ampullaceum										X		
C. areolatum									X	X	X	X
C. bractefoliaceum					X	X	X					
C. breedlovei							X	X	X			
C. brenesii	X?		X	X	X							
C. chavarrianum	X											
C. chiapense								X				
C. concinnum							X					
C. costaricanum				X	X	X	X					
C. effusum		X	X	X	X	X	X					
C. erythropus					X?	X						
C. formicarium								X	X			
C. glaziovii				X								
C. glossophyllum									X			
C. grisebachii	X				X		X	X				
C. hammelianum			X		X			X	X	X		
C. hartmanii		X		X	X							
C. hatschbachii				X		X						
C. haussknechtii				X	X							
C. heterantherum												
C. hirsutum				X								
C. kruseanum				X								
C. leptophyllum				X								
C. longipes								X				
C. napoense		X			X							
C. neurophyllum	X	X	X	X								
C. pachypodum			X?	X	X	X	X	X	X			
C. padiforme			X		X	X	X	X	X			
C. palaciosii												X
C. paratriplinerve				X	X	X	X					
C. pseudoglaziovii	X?	X	X	X								
C. quadrangulum				X		X		X				
C. rubrinervium					X							
C. salicifolium					X	X	X	X	X			
C. sellowianum			X?	X	X	X						
C. stenophyllum				X								
C. subsessile												
C. taubertianum						X?						
C. tomentulosum						X						
C. tonduzii							X	X	X			
C. triplinerve												
C. uninervium					X?							
C. velvetii				X								
C. zapatae							X	X	X	X	X	

Table 3. Altitudinal distribution known for the species of *Cinnamomum* in the Neotropics.

Stout, 1927). In these two species the mature flowers produce nectar and open twice, one day exposing the receptive stigmas first, and the anthers shedding pollen the next day. This system reinforces xenogamy, as shown in the crossing experiments performed by Kubitzki & Kurz (1984), where only xenogamous crosses yield mature fruits. There are no field observations about pollinators of *Cinnamomum*, but pollination might be made by the small bees belonging to the Meliponinae, as is the case in several neotropical genera of the Lauraceae (Kubitzki & Kurz, 1984).

Dispersal.

The fat-rich fruits of the Lauraceae are dispersed mainly by birds (Snow, 1981); the whole fruit is swallowed and the seed regurgitated later. Field observations have shown that some species of *Cinnamomum* are important in the diet of several species in the Ramphastidae, Trogonidae, Cotingidae, and Muscicapidae (Wheelwright et al., 1984). Production of fruit, however, is not necessarily constant throughout the years; not even at the population level (Wheelwright, 1986), at least in the case of the few species of *Cinnamomum* studied in the Neotropics.

Fossil record.

Fossil flowers belonging to the family Lauraceae are known from early Cretaceous times, about 95 million years ago (Drinnan et al., 1990; Herendeen et al., 1994). Fossil leaf remains related to *Cinnamomum*, on the other hand, have been recognized from the Paleocene through the Oligocene (Taylor, 1988, and references there). No fossil flowers with the particular morphology

of *Cinnamomum* have so far been found or described, yet some fossil flowers have been assigned to this genus (Conwetz, 1886 in Drinnan et al., 1990). Flowers with characters that suggest the relation to the group of genera where *Cinnamomum* is placed (*Ocotea* - *Cinnamomum* complex; sensu Kostermans, 1957) have been described from the Paleocene, ca. 45 million years ago (Taylor, 1988); these flowers were bisexual, with 6 tepals in two whorls of three each, stamens with four microsporangia, paired glands at the base of some filaments, and a distinct hypanthium. These data indicate that the genus *Cinnamomum* might have been present in the world flora since that geological period.

Taxonomic treatment.

Cinnamomum Schaeffer, Botanica Expeditior 74. 1760. nom. conserv.

Camphora Fabricius, Enum.: 218. 1759.

Camphorina Noronha, Verh. Batav. Genootsch. Kunsten 5: art 4.1. 1790.

Septina Noronha, Verh. Batav. Genootsch. Kunsten 5: art 4.3. 1790.

Cecidodaphne Nees, in Wallich, Pl. asiat. rar. 2: 70. 1831.

Partenoxylon Blume, Mus. bot. 1(21): 322. 1851.

Phoebe sect. Cinnamomoideae Meissner, in DC. Prodr. 15 (1): 29. 1864.

Temmodaphne Kostermans, Bot. Tidsskr. 68: 319. 1973.

Mostly medium sized or tall trees, up to 30 m, less frequently shrubs; leaves alternate or opposite,usually distinctly petiolate, entire, glabrous or variously pubescent, triplinerved, subtriplinerved or penninerved; inflorescences axillary to leaves or to small deciduous bracts,

cymose-paniculate, sometimes reduced to one single cyme or racemiform, simple or in short axillary racemes, often with foliose bracts at the base of main branchings; flowers perfect, small, pedicellate, pale greenish-yellow, or greenish-white, urceolate or narrow campanulate, tepals six, erect in anthesis, in two whorls of three, more or less the same size and shape, glabrous or pubescent outside, usually sericeous inside, fertile stamens nine, in three whorls of three, all four celled (pollen sacs in two overlapping pairs) or the third whorl two celled (upper pair of pollen sacs missing), anthers of whorls I & II introrse, anthers of whorl III with upper cells latrorse and lower ones extrorse or extrorse-latrorse, filaments of third whorl with a pair of glands at the base or above it, staminodes of fourth whorl well developed, head distinct, broader than its pedicel, cordate or triangular in outline, pedicelate, hypanthium distinct, shallow or more or lees deep, ovaries subglobose, glabrous or barely pilose, unilocular, with one pendulous ovule, styles as long as ovaries or longer, stigmas discoid or triangular; fruits baccate, ellipsoid or subglobose, black or purplish, when ripe, borne in a cupule whose rim is either fringed with the more or less indurate or fleshy persistent tepals (sometimes only their base persistent), or entire (tepals deciduous).

As currently circumscribed, *Cinnamomum* contains about 200-350 species (Kostermans, 1986; Rohwer, 1993a), most of them in the Old World tropics, mainly in southeastern Asia. Kostermans started the revision of the genus studying the species of southern India, Australia, and the islands of the Pacific region (Kostermans, 1985, 1986). The genus is absent from Africa.

Cinnamomum species are typically more numerous and abundant in humid mid-elevation regions along mountain ranges in tropical and subtropical areas. But a number of species occur

also in the lowlands and drier areas of both tropics. Most species are medium sized or tall trees.

Perhaps *C. camphora* and *C. verum* are the most well known species in the genus, for the production of camphor and cinnamon respectively. But there are several other species that are (or were) extensively used for the extraction of essential oils, e.g. *C. iners*, *C. malabathrum*, *C. nitidum*, and *C. tamala* (Gunther, 1950; Kostermans, 1986).

Key to the neotropical species of *Cinnamomum*

1. Leaf lower surface concealed by dense pubescence of tight wavy or curly hairs.

    2. Leaf base acute to attenuate; leaves elliptic, narrow elliptic or oblanceolate.

        3. Veins on lower surface of the leaf conspicuously covered with dark red hairs ..... *C. rubrinervium*

        3. Veins on lower surface of the leaf not covered with dark red hairs.

            4. Leaf length-width ratio 5:1 - 8:1; secondary veins 6 - 9 (11) ..... *C. stenophyllum*

            4. Leaf length-width ratio 1.5:1 - 4:1; secondary veins 3 - 5 ..... *C. sellowianum*

    2. Leaf base rounded or cordate; leaves ovate to ovate-lanceolate.

        5. Flower pedicel and outer surface of tepals glabrous; secondary veins (2) 3 pairs..... *C. taubertianum*

        5. Flower pedicel and outer surface of tepals pubescent; secondary veins (3) 4 - 5 pairs..... *C. kruseanum*

1. Leaf lower surface not concealed by pubescence (sometimes apparently so, but actually leaf surface is covered by scurfy whitish wax), hairs absent or present, straight to curly, appressed or erect.

    6. Leaf surface of mature leaves entirely glabrous above **and** below (veins may have some hairs). Twig hairs, if present, mostly straight and appressed (except *C. brenesii*).

        7. Domatia absent.

            8. Inflorescences pauciflorous, 1 - 3 dichasia each.

                9. Glands at base of stamens of whorl III present; leaf base attenuate; secondary veins 5 - 9 (10) ..... *C. chiapense*

                9. Glands at base of stamens of whorl III absent; leaf base rounded or truncate, often oblique; secondary veins 3 - 4 ..... *C. concinnum*

8. Inflorescence multiflorous, usually with more than 15 flowers each.

10. Tepals with an abscission line above their base, partially persistent in fruit.

11. Anthers of whorl III with 2 cells, hypanthium sericeous inside, twigs fistulose ..... *C. napoense*

11. Anthers of whorl III with 4 cells, hypanthium glabrous inside, twigs solid ..... *C. hammelianum*

10. Tepals without an abscission line above their base, whole persistent in fruit.

12. Petioles (23) 30 - 44 (50) mm long; leaf blades (27) 30 - 39 (45) cm long ..... *C. chavarrianum*

12. Petioles (0) 1.5 - 4 (6.5) mm long; leaf blades (1) 2.5 - 10 (25) cm long.

13. Leaf base short attenuate; leaves narrow elliptic ..... *C. uninervium*

13. Leaf base cordate, amplexicaul or not, or rounded, obtuse or truncate; leaves ovate or lanceolate, less often elliptic.

14. Petioles 2.5-3 mm wide; leaf blades 8-13 cm wide ..... *C. subsessile*

14. Petioles 0.5-2 mm wide; leaf blades 1.5-4.5 (6) cm wide.

15. Leaf apex acuminate or acute; plants from Mexico ..... *C. amplexicaule*

15. Leaf apex obtuse or rounded; plants from Brazil ..... *C. quadrangulum*

7. Domatia present, at least one or both of lower most pair in some leaves.

16. Hypanthium sericeo-pubescent inside, at least patches or strips of hairs present.

17. Tepals with an abscission line above their base, partially persistent in fruit ..... *C. brenesii*

17. Tepals without an abscission line, entirely persistent in fruit.

18. Domatia leaf surface area flat above and below.

19. Twigs winged; flower pedicel (10) 12 - 20 (24) mm long ..... *C. longipes*

19. Twigs terete or slightly ridged; flower pedicel not over 6 mm long ..... *C. triplinerve*

18. Domatia leaf area usually concave below, flat or more or less ampullose above.

20. Inflorescences a single 3 - flowered cyme; leaves caudate, thin-herbaceous ..... *C. leptophyllum*

20. Inflorescence cymose-paniculate; leaves acute to acuminate, rather chartaceous .. *C. areolatum*

16. Hypanthium glabrous inside.

21. Tepals with an individual abscission line above their base, or a single line below their base, partially or not persistent in fruit.

22. Tepals falling off as a unit, not persistent in fruit; inflorescence pauciflorous, 1 - 3 dichasia each; leaves (1.5) 3 - 4.5 (5.5) cm long ..... *C. hatschbachii*

22. Tepals with an abscission line above their bases, partially persistent in fruit; inflorescence multiflorous, usually with more than 15 flowers each; leaves (6.5) 12.5 - 23 (30) cm long ..... *C. neurophyllum*

22. Tepals without an abscission line, whole persistent in fruit.

23. Primary domatia present at several pairs of secondary veins, secondary domatia present at least in some leaves; lowest pair of secondary veins not strongly ascending ..... *C. effusum*

23. Primary domatia present only at lower most pair of secondary veins, secondary domatia absent; lowest pair of secondary veins strongly ascending.

24. Fruit pedicel turbinate from top to bottom, conspicuously swollen all its length; last branching of inflorescence usually congested ..... *C. grisebachii*

24. Fruit pedicel turbinate distally, proximal section rather cylindrical; last branching of inflorescence not congested ..... *C. costaricanum*

6. Leaf surface of mature leaves sparse to densely pubescent at least below (sometimes inconspicuously so). Twig hairs straight to curly, appressed to erect.

25. Indument on lower leaf surface made **only** of straight appressed hairs, sometimes inconspicuous.

26. Domatia absent; twigs fistulose.

27. Leaves conspicuous and densely pubescent underneath, usually 14.5-22.5 cm wide ..... *C. formicarium*

27. Leaves incospicuous and sparsely pubescent underneath, usually 5.5-10 cm wide ..... *C. napoense*

26. Domatia present; twigs not fistulose.

28. Leaf area of domatia concave below, ampullous above.

29. Stamens of whorl III with two sporangia; leaves pinninerved ..... *C. heterantherum*

29. Stamens of whorl III with four sporangia; leaves triplinerved or subtriplinerved.

30. Tepals with an abscission line below their bases, not persistent in fruit; fruit pedicel not distinct, turbinate from top to bottom ..... *C. alainii*

30. Tepals persistent (at least partially) in fruit; fruit pedicel partially distinct, turbinate distally.

31. Inflorescence pauciflorous, 1 (3) dichasia each; tepals entirely persistent, complete ..... *C. ampullaceum*

31. Inflorescence multiflorous, usually more than 15 flowers each; tepals partially persistent ..... *C. amoenum*

28. Leaf area of domatia flat above and below.

32. Secondary domatia present, at least in some leaves.

33. Hypanthium glabrous outside and inside ..... *C. effusum*

33. Hypanthium mostly pubescent outside, sericeous inside ..... *C. triplinerve*

32. Secondary domatia absent.

34. Tepals without an abscission line, entirely persistent in fruit.

35. Lower leaf surface with irregular dark spots ..... *C. salicifolium*

35. Lower leaf surface without dark spots ..... *C. triplinerve*

34. Tepals with an abscission line above or below their bases, partially or not persistent in fruit.

36. Tepals falling off as a unit soon after anthesis, not persistent in fruit ..... *C. glaziovii*

36. Tepals with an abscission line above their base, partially persistent in fruit .....

..... *C. paratriplinerve*

25. Indument on lower leaf surface made of wavy to curly hairs, appressed to erect, if straight hairs present, these mainly spreading or erect.

37. Domatia absent.

38. Twigs fistulose ..... *C. formicarium*

38. Twigs not fistulose.

39. Leaves pinninerved, if subtriplinerved then secondaries 5-10 pairs ..... *C. erythropus*

39. Leaves triplinerved or subtriplinerved, secondaries 3-5 pairs.

40. Stamens of whorl III with four sporangia; flower pedicel pubescent ..... *C. hirsutum*

40. Stamens of whorl III with two sporangia; flower pedicel glabrous ..... *C. haussknechtii*

37. Domatia present; twigs not fistulose.

41. Secondary domatia absent.

42. Flower pedicel and outer surface of tepals conspicuously pubescent; fruit pedicel not distinct.

43. Leaves obovate to oblanceolate; secondary veins 4 - 5 pairs; lower leaf surface hirsute, quite visible through hairs ..... *C. hirsutum*

43. Leaves lanceolate (rarely ovate or elliptic); secondary veins (6) 7 - 9 (10) pairs; lower leaf surface densely tomentose and waxy, hardly visible ..... *C. velvetii*

42. Flower pedicel glabrous, tepals glabrous or sparsely pubescent outside.

44. Tepals without an abscission line, entirely persistent in the fruit ..... *C. pachypodum*

44. Tepals with an abscission line above their base, partially persistent in fruit.

45. Anthers of stamens of whorl III with two cells, if four then the upper ones about one fourth of the size of the lower ones or less.

46. Lower surface usually glaucous; leaves ovate (or elliptic); apex obtuse or acute ..... *C. haussknechtii*

46. Lower surface not glaucous; leaves elliptic, apex acute to long acuminate ..... *C. tomentulosum*

45. Anthers of stamens of whorl III with four cells, all about the same size.

47. Remnants of tepals erect, clasping fruit base; leaves mainly pinnate to subtriplinerved ..... *C. hartmanii*

47. Remnants of tepals rather spreading; leaves triplinerved or slightly subtriplinerved ... *C. brenesii*

41. Secondary domatia present (at least in some leaves).

48. Tepals with an abscission line above their base, partially persistent in fruit.

49. Leaves ovate or elliptic; twig indument made only of curly hairs, appressed to spreading; anther cells in stamens of stamens of whorl III similar in size ..... *C. tonduzii*

49. Leaves obovate to oblanceolate; twig indument made of straight appressed hairs and wavy to curly erect hairs; anther cells in stamens of whorl III of different size, upper ones conspicuously smaller than lower ones ..... *C. pseudoglaziovii*

48. Tepals without an abscission line,whole persistent in the fruit.

50. Distal part of twigs and lower leaf surface of young leaves with glomerules of white wax ..... *C. breedlovei*

50. Distal part of twigs and lower surface of young leaves without glomerules of white wax.

51. Outer tepals glabrous inside; flower pedicel and outer tepals surface glabrous; hypanthium sericeous inside ..... *C. palaciosii*

51. Outer tepals sericeous inside; flower pedicel and outer tepal surface pubescent, if both glabrous then hypanthium also glabrous.

52. Leaves obovate to oblanceolate; hairs on lower leaf surface straight to slightly wavy,

erect; domatia mostly inconspicuous ..... *C. hirsutum*

52. Leaves wide ovate to lanceolate, elliptic or narrow elliptic; hairs on lower leaf surface mostly wavy to curly, if hairs straight then domatia conspicuous.

53. Hypanthium entirely glabrous or with some hairs on upper half inside.

54. Hairs on lower leaf surface wavy, appressed; secondary domatia restricted to lower most secondaries ..... *C. bractefoliaceum*

54. Hairs on lower leaf surface straight to slightly wavy, spreading to erect; secondary domatia usually present along several secondaries pairs .... *C. padiforme*

53. Hypanthium conspicuous and evenly sericeous inside.

55. Leaf base obtuse to rounded; leaves mostly wide ovate to ovate; upper leaf surface glabrous ..... *C. zapatae*

55. Leaf base cuneate; leaves narrow elliptic to lanceolate; upper leaf surface tomentose ..... *C. glossophylum*

Cinnamomum alainii (C.K. Allen) Alain, Phytologia 50: 162. 1982.

Phoebe alainii C. K. Allen, Mem. New York Bot. Gard. 21: 109. 1971. Type. Dominican Republic. La Vega: ridge E of Loma de la Sal, between Jaracoba and Constanza. *A. Liogier 11993* (holotype, NY!; isotypes, BM!, GH!, NY!, P!, US!).

Cinnamomum alainii (C. K. Allen) Kostermans, Reinwardtia 10: 439. 1988. Nom. illeg.

Trees 3 - 8 m tall; twigs rather terete, sparsely to densely pubescent, hairs (0.1) 0.2 - 0.3 mm long, straight, appressed or slightly spreading; petiole (3) 4 - 5.5 (7) mm long, 0.8 -1.2 mm wide, sparsely pubescent, hairs as on twigs; leaf blades (2) 3.5 - 6 cm long, (1) 2 - 3 cm wide,

ovate, apex acuminate to long acuminate, base acute, glabrous above, sparsely pubescent to glabrescent below, hairs straight and appressed, triplinerved, less frequently subtriplinerved, midvein slightly marked above, pubescent, glabrescent with age, strongly raised below, pubescent to sparsely pubescent, hairs as on twigs, secondary veins (3) 4 - 5 pairs, lowest pair flat above, sparsely pubescent, glabrous with age, raised below, sparsely pubescent to glabrescent with age, other secondaries almost inconspicuous above and below, tertiary veins flat above and below, primary domatia present, lowest pair only, sunken below, ampullous above, secondary domatia absent; inflorescence 1.5 - 3.5 cm long, axillary to leaves, cymose or "racemiform", pauciflorous (just one or two branchings of main axis), peduncle 0.7 - 2.5 cm long, glabrescent, rachis (when present) glabrescent or glabrous, flower pedicel 3 - 4.5 (5.5) mm long, glabrous; flowers narrow campanulate (?) or urceolate, tepals 2.1 - 2.5 mm long, 1.4 - 1.8 mm wide, ovate, glabrous outside, sericeous inside, inner ones densely so, stamens of whorls I & II 1.5 mm long, filaments sparsely sericeous on lower third adaxially, glabrous or sparsely sericeous on the base abaxially, anthers 0.8 - 0.9 mm long, glabrous ad and abaxially, sporangia four, in two pairs, introrse, stamens of whorl III 1.5 mm long, filaments sparsely sericeous adaxially, sparsely sericeous on lower half along median section abaxially, anthers 0.7 mm long, glabrous ad and abaxially, sporangia four, upper ones latrorse, lower ones latrorse-extrorse, glands ca. 0.5 mm long, around the middle part of the filament, sparsely sericeous adaxially at point of attachement, glabrous elsewhere, staminodes 0.8 - 0.9 mm long, filament sericeous ad and abaxially, head 0.5 - 0.6 mm long, narrow ovate triangular in outline, glabrous adaxially, glabrous or glabrescent abaxially, hypanthium 1 - 1.2 mm deep, glabrous outside, sericeous inside, pistil 1.9 - 2.2 mm long, glabrous, ovary 1.1 - 1.2 mm long, 0.9 1.1 mm wide; fruit ca. 9.5 mm long, ca. 6.5 mm

wide, ellipsoid, cupule 5.5 - 6 mm long, 3.5 mm wide above, 0.9 - 1.3 mm wide below, pedicel not distinct, tepals not persistent, falling off as one piece soon after anthesis.

Known to flower in August; fruits in November. In wet forests at altitudes of 900-1500 m. This species is known only from the central mountain ridges in the Dominican Republic.

C. alainii morphologically looks very close to *C. hatschbachii*. They differ in the number of pairs of secondary veins, pubescence of lower surface of leaves, and number of domatia; *C. alainii* having usually 4-5 pairs of veins, lower leaf surface with straight appressed hairs, and only the basal pair of domatia, while *C. hatschbachii* has usually 2 pairs of veins, glabrous leaf undersurface, and one or two pairs of domatia.

C. alainii is considered in the group of neotropical species of *Cinnamomum*, despite the total abscission of its tepals. The combination of staminodes with head well developed, distinct hypanthium, triplinerved leaves, and presence of domatia, suggest a strong relation of this species with the species of *Cinnamomum* that have persistent tepals.

Specimens examined. DOMINICAN REPUBLIC. On ridge, E. of Loma de la Sal. Between Jarabacoa and Constanza, *A. Liogier 11993* (NY(2 sheets), GH, BM, P, US); Alto Casabito, Constanza, *A. Liogier 18258* (F); Cordillera Central: La Vega, Loma La Golondrina, al S de Jarabacoa, cerca del poblado de La Sal, Paso Bajito, *T. Zanoni et al. 35761* (NY); Cordillera Central: La Vega-San Cristóbal-Peravia, 10km de Rancho Arriba en la carr. a Piedra Blanca y 4 km SE hasta Mahoma y Río Mahoma, en las orillas del Río Mahoma, *T. Zanoni et al. 22894* (NY); Cordillera Central: Sto. Domingo, Top of Loma La Campana, *E. L. Ekman 11506* (S).

Cinnamomum amoenum (Nees et Martius) Kostermans, Reinwardtia 6: 20. 1961.

Oreodaphne amoena Nees et Martius, Linnaea 8: 44. 1833. Type. Uruguay. Montevideo. *Sellow 3174* (lectotype, B!, chosen here; isolectotype, B!).

Phoebe amoena (Nees et Martius) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 207. 1889.

Oreodaphne vesiculosa Nees et Martius, Linnaea 8: 44. 1833. Type. Brazil. *Sellow s/n*, (syntype, G!).

Phoebe vesiculosa (Nees et Martius) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 206. 1889.

Cinnamomum vesiculosum (Nees et Martius) Kostermans, Reinwardtia 6: 24. 1961.

Trees 4 - 10 (12) m, or shrubs ca. 1.5 m tall; twigs ridged to angulate when young, soon terete, pubescent, sometimes densely so, hairs 0.1 - 0.3 mm long, straight and appressed or subappressed, glabrescent with age; petiole (1.5) 3.5 - 7 (9) mm long, (0.4) 0.6 - 0.9 (1.1) mm wide, glabrous or pubescent, hairs as on twigs; leaf blade (1.5) 4 - 7.5 (11) cm long, (0.5) 1 - 2 (3.5) cm wide, elliptic, narrowly elliptic or few oblanceolate, apex acute to short acuminate, base acute to short attenuate, sparsely pubescent above when young, glabrous with age, densely pubescent to glabrescent below, hairs straight and appressed, sutriplinerved, triplinerved, or even pinnate veined, midvein flat to slightly sunken above, pubescent when young, glabrous with age, strongly raised below, usually pubescent, hairs as on leaf surface, secondary veins (4) 5 - 6 (7) pairs, flat above, glabrous, raised below, sparsely pubescent to glabrous, tertiary veins flat above, rather so below, primary domatia present, usually several pairs besides the basal ones, sunken below, slightly to strongly ampullaceous above, secondary domatia absent; inflorescence (2.5) 5

- 9.5 (13.5) cm long, axillary to leaves, rarely to small deciduous bracts, cymose-paniculate, sometimes last branchings congested, foliose bracts sometimes present, peduncle (0.3) 2 - 4.5 (6) cm long, glabrescent or glabrous, rachis mostly glabrous, flower pedicel (2.5) 3.5 - 6 (7.5) mm long, glabrous; flower urceolate, cream, greenish, or pale greenish yellow, tepals 1.8 - 2.5 mm long, 1.2 - 1.7 mm wide, ovate, glabrous outside, inner ones sometimes sparsely pubescent, all short sericeous inside, stamens of whorls I & II 1.5 - 1.9 mm long, filament sericeous ad and abaxially, sparsely so abaxially, anthers 0.8 -1 mm long, sericeous along connective base adaxially, otherwise glabrous, sporangia four, stamens of whorl III 1.6 - 1.9 mm long, filament sericeous ad and abaxially, anthers 0.7 - 0.9 mm long, sericeous adaxially, glabrous abaxially, sporangia four, rarely one or both two upper ones fused with lower ones, glands ca. 0.5 mm long, just above filament base, sericeous adaxially, staminode 0.9 - 1.2 mm long, filament sericeous ad and abaxially, sometimes glabrescent adaxially, head 0.5 - 0.8 mm long, cordate in outline, acuminate, glabrous adaxially, or sericeous at base, sparsely sericeous on base abaxially, hypanthium 0.4 - 0.6 mm deep, glabrous outside, sericeous inside, or glabrescent, pistil 1.9 - 2.3 mm long, glabrous, ovary 0.8 - 1.2 mm long, 0.8 1.1 mm wide; fruit 8 - 12 mm long, 6 - 11 mm wide, ellipsoid, cupule 1.5 - 4 mm long, 4 - 6.5 mm wide, pedicel 3 - 10.5 mm long, 1.8 - 3 mm above, 0.8 - 1.2 mm below wide, just the very base of tepals persistent, rarely wholly deciduous as one piece.

Flowers present from October to December. No record of when fruits are present. Vegetation type: pinhaes, secondary forest, mata, capão. Between (550) 800 - 1000 (1100) m altitude. *C. amoenum* occurs in the temperate zone of Brazil (Paraná to Rio Grande do Sul),

Uruguay, and the northwestern tip of Argentina.

C. amoenum seems to be an extreme in the morphological variation of *C. triplinerve*. However, the consistent correlation of narrow elliptic leaves, along with ampullaceous domatia, and tepals partially persistent in fruit found in *C. amoenum*, separates it clearly from the variable *C. triplinerve* that reaches the eastern edge of distribution range of that species.

At the same time, the presence of appressed straight hairs on leaf lower surface, coupled with tepals mostly glabrous outside and partially persistent, and usually several pairs of ampullaceous domatia help to distinguish *C. amoenum* from other species in the area of southwestern Brazil.

The situation in *C. amoenum*, that of two names given to the same species based on flowering and fruiting material respectively, is found very often in the taxonomic history of the Lauraceae. In this case, the difficulty in matching type material of *Oreodaphne amoenum* (flowers) with that of *Oreodaphne vesiculosum* (fruits) was increased by the morphological extremes that those collections represented. But with more collections at hand, it is easy to see the gradation and different combinations that distinctive characters, used in the original descriptions, have in the area where this species grows. Thus, it is evident that the ampullaceous projections of domatia on upper leaf surface are present whether the lower surface is dense glauco-pubescent or not; also, triplinerved leaves are not linked necessarily with a particular kind of pubescence or to the presence of ampullaceous domatia.

In the original description of *Oreodaphne amoena*, Nees did not cite any particular collection by Sellow, but later, in his Systema Laurinarum (Nees, 1836), he gives *Sellow 1459* and *3174*, as the material studied for that species. The annotation found on number *3174*

corresponds to that given in the original description as the collection place "Brasilia australi ad Monte Video", and thus I chose one of the two duplicates of this collection at B as the lectotype.

The typification of *Oreodaphne vesiculosa* is not satisfactorily solved. Nees did not give any specific number for Sellow's collection, and he did not give any further information in his Systema Laurinarum. Meissner, however, gives *Sellow 4597* as the material studied for that species, but in the material borrowed from different herbaria for this study that Sellow collection was not found. The only annotated material as a possible type is a Sellow collection at G without number.

Specimens examined. ARGENTINA. **Misiones**: Guaraní, *A. Borhen 10* (MO). BRAZIL. **Paraná**. União da Vitoria, Rio Iguaçú, *C. Koczicki 268* (MO, MBM); Near old camp 6 km N of Rio Iguaçú, SE of Campo Novo, *J.C. Lindeman & J.H. de Haas 2899* (MBM, RB); Paraná: São Matheus, *L. Gurgel s.n.* (RB); General Carneiro, Fazenda Rondon, na estrada Rio das Antas, *H.G. Richter 61* (RB); Laranjeiras do Sul, Rod. BR-277, Reserva Indigena, G. & M. Hatschbach 52392 (SP, MO, U, W); Floresta Nacional de Irati, *H. G. Richter 15* (RB); Rio Negro, Estação Exp. Florestal SCA/UFP, local da coleta encontrase na BR 116, km 101 ao Sul de Curitiba, *H.G. Richter 6* (RB); Colombo, Capivari, *G. Hatschbach 27627* (MBM, MO); Campo Mourao, *G. Hatschbach 12963* (HB, RB (2 sheets), MBM, MO); Campo Mourao, *G. Hatschbach 12965* (MO); Guarapuava, Canta Gallo, *E. Pereira & G. Hatschbach 10335* (RB); Colombo, Bacaitava, *G. Hatschbach 8415* (RB, MO); Pinhaes, *P. Dusen 15802* (G, F, NY, S); São Mateus do Sul, Lajeadinho, *G. Hatschbach 39749* (S, MBM, C, MO); Tijucas do Sul, Saltinho, *G. Hatschbach 50882* (S, MO, C); Curitiba, Pilarzinho, *C. Koczicki 361* (S, MBM,

MO); General Carneiro, Faz. Rondon, estrada p/a tela p/dentro do patio (exploração imbuia), *H.G. Richter 60* (RB); General Carneiro, Faz. Rondon, na estrada Rio das Antas., *H.G. Richter 56* (RB); Palmyra, , *Gurgel s.n.* (RB (5 sheets)); Campina, Rio Branco do Sul, *R.M. Klein 2488* (RB, MBM, SP); Curitiba, Centro Civico, *G. Hatschbach 40671* (MBM, MO); Laranjeiras do Sul, Rio Tapera, *G. Hatschbach 18395* (MBM, F); Bituruna, Bituruna, *G. Hatschbach et al. 13869* (RB, U); enter Palmyra et Canta Gallo., *Gurgel 16137* (U). **Rio Grande do Sul**. Vila Oliva para Caxias, *B. Rambo 44666* (RB); Taimbezinho para S. Francisco de Paula, *B. Rambo SJ 49350* (RB); Enteio para P. Alegre, *B. Rambo SJ 49171* (RB, B); Faxinal, Cambara do Sul, *M. Sobral 2670* (MBM); in summo monte Itacolumi para Gravatai, *B. Rambo SJ 45253* (B); Sapyranga, *J. Dutra 740* (U); Montenegro, *A. Sehnem s.n.* (B). **Santa Catarina**: Agua Dulce, 16 km south of Horizonte, Paraná, *L.B. Smith & R.M. Klein 15590* (F); Bom Retiro, Pinheiral, Campina, Riozinho, *L.B. Smith & R.M. Klein 7925* (RB, S (2 sheets)); Ponte Alta do Sul, Curitibanos, *R. Klein 3225* (B, MBM); Curitibanos, *R. Klein 3269* (MBM, B, RB, US); Morro do Pinheiro, Lajes, *Reitz & Klein 14045* (B, RB, MBM); Fazenda dos Carneiros, Caçador, *R. Klein 3460* (RB); Imbituba, Nova Esperança, *G. Hatschbach 40375* (MBM, MO); Tres Barras, FLONA, *H.G. Richter 20* (RB); Bom Jardim da Serra, *Este 1639-3*? (RB); Campo Alegre, Morro de Iquererim,, *Reitz & Klein 6388* (RB); Lajes, Pinheiral, 17 km NE of Bocaina do Sul, *L.B. Smith & R.Klein 11260* (NY, RB); São Jose, Serra da Boa Vista, *Reitz & Klein 10763* (HB, SP, G, MBM, BR, RB); without precise locality, *L. Smith 10567* (RB). Without precise locality, *Sellow 1459* (B (2 sheets), F); *Sellow s.n.* (B, G (2 sheets)). URUGUAY. Montevideo, *Sellow 3174* (B (2 sheets)).

Cinnamomum amplexicaule (Schlechtendal et Chamisso) Kostermans, Reinwardtia 6: 20. 1961.

Persea amplexicaulis Schlechtendal et Chamisso, Linnaea 5: 90. 1830. Type. Mexico. Veracruz: Cerro Colorado, between Xalapa and volcano Cofre de Perote, August 1828, *Schiede 87* (holotype, B!).

Phoebe amplexicaulis (Schlechtendal et Chamisso) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 216. 1889.

Trees 3 - 8 m, or shrubs to 3 m tall; twigs ridged, ridges coming down from petiole bases, almost smooth with age, sparsely tomentose, soon glabrous, hairs straight and appressed or more or less spreading; petiole absent or (1) 2 - 5 (6.5) mm long, (0.5) 1 - 2 mm wide, glabrous; leaf blade (4) 8 - 15.5 (23) cm long, (1.5) 2.5 - 4.5 (6) cm wide, lanceolate, less frequently ovate, narrowly elliptic or elliptic, apex acuminate, acute or blunt-obtuse, base cordate, amplexicaule or not, or round, truncate or obtuse, glabrous on both surfaces, sparsely pubescent when young, hairs as on twigs, pinnatinerved, midvein slightly depressed above or flat, strongly raised below, glabrous or inconspicuously pubescent, hairs as on twigs, secondary veins (6) 7 - 10 (12) pairs, flat above, raised below, tertiary veins flat above, slightly raised below, domatia absent; inflorescence (5.5) 7.5 - 13.5 (17) cm long, axillary to leaves, cymose, loosely paniculate, sometimes with small foliose bracts at main branchings, peduncle (2.5) 4.5 - 8.5 (11) cm long, glabrous or sparsely pubescent, rachis glabrous or sparsely pubescent, flower pedicel (3.5) 5 - 13 (16) mm long, glabrous, rarely sparsely pubescent; flower narrow campanulate, pale yellowish

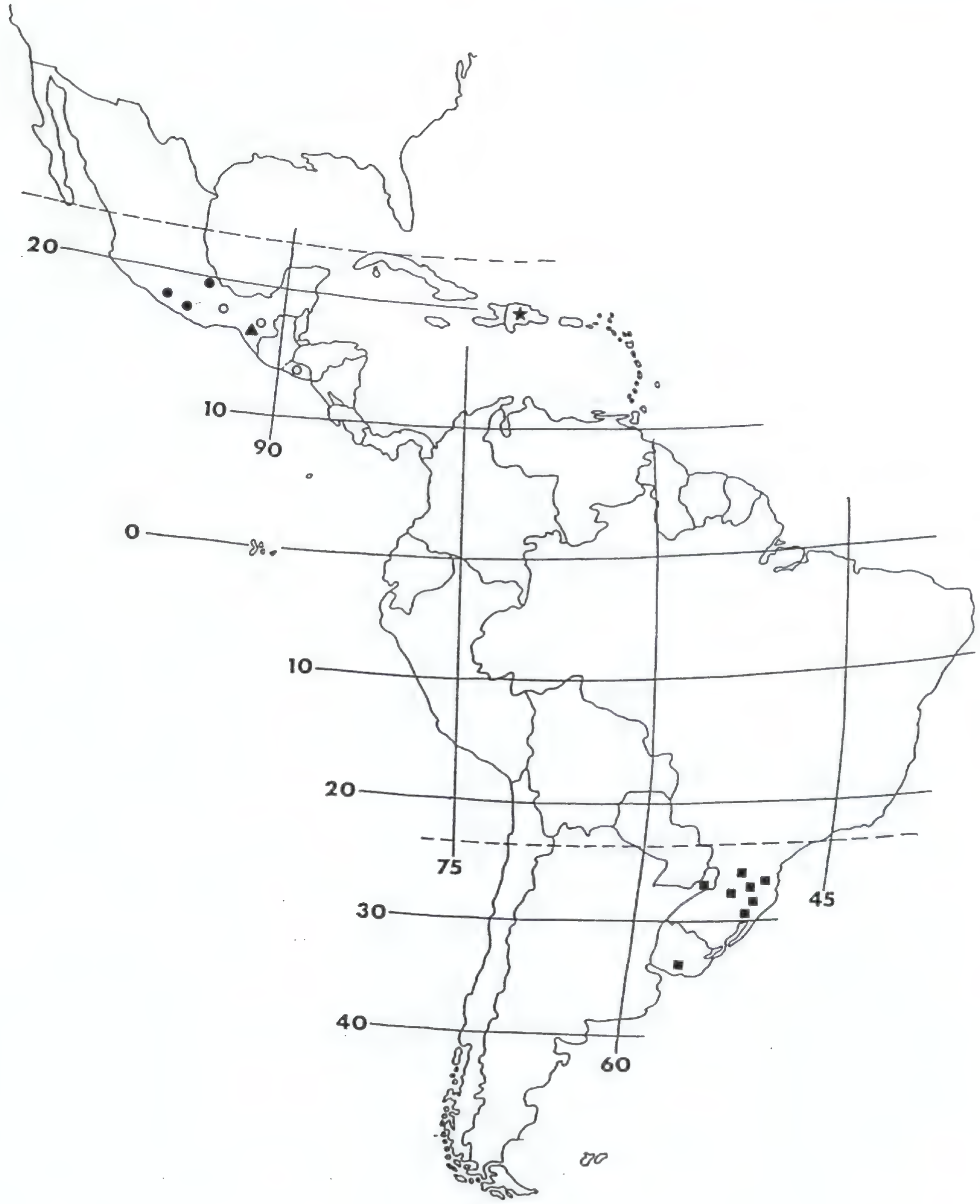


Figure 4. Known distribution of (★) *C. alainii*, (■) *C. amoenum*, (●) *C. amplexicaule*, (▲) *C. ampullaceum*, and (○) *C. areolatum*.

white, tepals 2 - 2.5 mm long, 1.5 - 2.2 mm wide, ovate, glabrous outside or sparsely pubescent, sericeous inside, sometimes sparsely so the outer ones, red hairs often present, stamens of whorls I & II 1.1 - 1.7 mm long, filaments sericeous ad and abaxially, mostly at base and along median section, sometimes glabrous adaxially, anthers 0.7 - 1.1 mm long, glabrous, sporangia four, stamens of whorl III 1.1 - 1.6mm long, filament sericeous ad and abaxially, sometimes sparsely so, anthers 0.7 - 0.9 mm long, glabrous or sparsely pubescent at base and margins adaxially, sporangia four, glands 0.3 - 0.5 mm long, at filament base, sericeous adaxially, staminode 0.5 - 0.9 mm long, filament sericeous ad and abaxially, head 0.4 - 0.5 mm long, narrowly triangular or roughly ovate in outline, glabrous adaxially, glabrous or sparsely sericeous abaxially at base, hypanthium ca. 0.5 mm deep, glabrous or sparsely pubescent outside, glabrous or sericeous inside, hairs often in patches, red hairs sometinmes present, pistil 1.8 - 2.3 mm long, glabrous, ovary ca. 1.2 mm long, ca. 1 mm wide; fruit 9 - 13 mm long, 7 - 9.5 mm wide, ellipsoid, cupule 6 - 9 mm long, 3 - 6 mm wide, pedicel absent, or 2 - 7 mm long, 1 - 1.2 mm wide, tepals persistent.

Flowers have been recorded (so far only in western Mexico populations) in December, February and May. Ripe fruits are present in August - September (in eastern Mexico populations), and in March (western populations). The types of vegetation where this species grows include mixed temperate forest, pine-oak forest, oak forest, and tropical deciduous forest; between 650-1150 (1650) m altitude. Distribution range is localized in two areas of Mexico: around Xalapa and Orizaba in Veracruz (facing the Gulf of Mexico), and in some places along the Sierra Madre del Sur in Guerrero and Oaxaca (facing the Pacific Ocean).

C. amplexicaule and *C. quadrangulum* look very alike. However, in the latter twigs are

narrow winged and glabrous, at least some leaves are triplinerved, and stamens of whorl III tend to be only with two sporangia, while the former has twigs more or less pubescent, ridged, leaves always pinninerved, and anthers of whorl III with four sporangia.

I have not found duplicates of the *Schiede 87* collection. Thus, following recommendation 9A.4 of the International Code of Nomenclature (Greuter et al., 1994), since no other collections were mentioned in the original description, I accept the specimen housed at B as the holotype. That Cerro Colorado is in this part of the state of Veracruz was found reading Schiede's (1828) reports on his travels along with Deppe in Mexico.

No further collections of the species have been made for almost 150 years.The second collection (*Ventura 11880*) is just a few miles northwest of the original locality. Schiede's and Ventura's collections (both with fruits) are amazingly alike, and the fact that they come from the same region in Mexico supports the idea that they belong to the same species. However, the other material I place under this name comes from the Pacific region and presents a wide morphological variation. Two reasons made me put them together (at least temporarily): first, the presence of some specimens from the Pacific region that closely match the material from the Atlantic area, pointing out they are conspecific; secondly, with only two individual collections from the Atlantic area I cannot determine how variable the populations are in this region and assess their overlap with populations in the Pacific region. However, the great separation between them without any other population somewhere in the middle, rather supports the idea of two different species.

Specimens examined. MEXICO. **Guerrero**. San Luis Acatlán, Mojonera de Atotonilco a

11 km al NW de Horcasitas, camino San Luis Acatlán-Pascala del Oro, *E. M. Martínez 3541* (MO); San Luis Acatlán, Potrerillos del Rincón, camino San Luis, *V. C. Aguilar 1420* (FCME (3 dups)); San Luis Acatlán, 8 km de Potrerillos del Rincón, hacia Iliatenco, *M. G. Campos 1935* (FCME (2 dups)); 2 km adelante de la desviación a El Edén, carretera Atoyac - Puerto El Gallo, *R. M. Fonseca 516* (FCME (3 dups)); Atoyac de Alvarez, Aprox. 5 km al Sde Nueva Delhi, camino Atoyac-Puerto El Gallo, *F. Lorea 5548* (FCME (25 dups)); Tecoanapa, Los Magueyes desv. hacia Colotepe sobre la Carretera Tierra Colorada-Ayutla de los Libres, *V. C. Aguilar 1522* (FCME (2 dups)). **Oaxaca**. Putla, a 10 km al NE de Putla., *L. Rico et al. 555* (MO). **Veracruz**. Cerro Colorado, between Xalapa and volcano Cofre de Perote, *Schiede 87* (B); Atzalan, La Florida, *F. Ventura 11880* (ENCB).

Cinnamomum ampullaceum Lorea-Hernández, sp. nov. TYPE: Mexico. Chiapas: Mpo. Larrainzar, km 4 on the road Xanaté - Bochil, 1860 m, 16 de Abril de 1993 (fl), *M. González et al. 1910* (holotype, CIES; isotype, MO).

Frutices vel arbusculae. Folia lanceolata aut rarius anguste elliptica, apice caudato-acuminato, triplinervia aut subtriplinervia, infra subglabra vel inconspicue pubescentia trichomatibus rectis, adpressis; domatiis praesentibus, plerumque ad axillas venarum secundariarum paris basalis tantum, pagina foliari ad domatia infra concava, supra ampullacea. Inflorescentia plerumque ex cyma solitaria constans, bracteis foliaceis carens. Flos tepalis extus sicut pedicello glabris, hypanthiuo intus glabrescente; tepalis integris in fructu persistentibus.

Shrubs or small trees 3.5 to 10 m tall; twigs sparse and inconspicuosly pubescent, hairs 0.2 (0.3) mm long, stright, appressed, glabrous with age; petioles (3) 4 - 6 (8) mm long, (0.5) 0.7 - 1 (1.2) mm wide, sparsely pubescent, hairs as on twigs; leaf blades (3.5) 5.5 - 10 (12.5) cm long, (1) 1.5 - 2.5 (3) cm wide, lanceolate or narrowly elliptic, apex caudate-acuminate, base acute, sparsely pubescent above when young, hairs straight, appressed, soon glabrous, sparsely and inconspicuously pubescent below, hairs straight and appressed, glabrescent with age, triplinerved or subtriplinerved, midvein sunken to marked above, glabrous, raised below, sparsely pubescent to glabrescent, hairs straight, appressed, secondary veins (5) 6 - 7 (8) pairs, distinct but flat above, glabrous, slightly raised below, glabrescent or glabrous, tertiary veins flat above, slightly raised below, primary domatia usually present, commonly just the basal pair, sunken below, sharply gibbous above, secondary domatia absent; inflorescence 2 - 3.6 cm long, axillary to leaves or to tiny deciduous bracts, a single triflorus cyme, rarely with two branchings, peduncle 1.5 - 2.8 cm long, glabrescent or glabrous, flower pedicel 4 - 8 mm long, glabrous; flower pale greenish yellow, urceolate, tepals 2 - 2.5 mm long, 1.5 - 1.8 mm wide, ovate or wide ovate, glabrous outside, sericeous inside, stamens of whorls I & II 1.5 mm long, filaments sericeo-pilose ad and abaxially, mainly on lower half of both sides, anthers 0.8 mm long, glabrous ad and abaxially, sporangia four, in two pairs, introrse, stamens of whorl III 1.5 mm long, filaments glabrous adaxially, very sparsely sericeous abaxially on lower half, anthers 0.7 mm long, glabrous ad and abaxially, sporangia four, in two pairs, upper ones latrorse, lower ones extrorse, glands 0.5 - 0.6 mm long, at filament base, ovate, sericeous at attachment point adaxially, glabrous abaxially, staminodes 1 mm long, pedicel glabrous adaxially, sericeous abaxially (on upper half) and on margins, head 0.6 mm long, triangular, plicate, not much

broader than filament, glabrous ad and abaxially, hypanthium 0.5 - 0.6 mm deep, glabrous outside, glabrescent inside, only two or three strips of scattered sericeous hairs coming from staminodes margins, pistil glabrous, ovary mm long; fruit ca. 7 mm long, 5 mm wide, ellipsoid, cupule ca. 6.5 mm long, 2.6 mm wide, pedicel 1.2 mm long, 0.6 mm wide, tepals persistent.

Flowers and fruits present in April. In oak mixed forest, at 2400 m altitude. So far this species is known only from the central region of the highlands of Chiapas, Mexico.

Paratypes. MEXICO. **Chiapas**: Mpo. Huixtán, Rancho Merced Bazón, between San Cristóbal de Las Casas and Ococingo, 2400 m, (fr), *F. Lorea 5515* (FCME, MO).

The name of the species refers to the ampullaceous condition of the single pair of domatia present in the leaves. It is not the only species of neotropical *Cinnamomum* with this feature, but it is this character that distinguishes it from other species in this part of Mexico.

The type of hairs present on twigs and lower leaf surface, along with the morphology of domatia in this species, relates it to *C. alainii* and *C. hatschbachii*. But *C. ampullaceum* is distinct in its lanceolate or narrowly elliptic leaves, the 6-7 pairs of secondary veins, and for having entirely persistent tepals in the fruit. See also comments under *C. leptophyllum*.

Cinnamomum areolatum (Lundell) Kostermans, Reinwardtia 6: 20. 1961.

Phoebe areolata Lundell, Contr. Univ. Michigan Herb. 7: 13. 1942. Type. Mexico. Chiapas: Sierra Madre, Saxchanal, 1 July 1941, *E. Matuda 4296* (holotype MICH!; isotypes A!, F!,

LL!, MO!, NY!).

Trees 3 - 10 (16) m, or shrubs 2 - 4.5 m tall; twigs more or less flat to quadrangular when young, ridged, ridges low but conspicuous, soon terete, pubescent or glabrescent, hairs 0.15 - 0.25 mm long, straight and appressed; petiole (4) 6.5 - 13.5 (19) mm long, (0.6) 0.9 - 1.4 mm wide, sparsely pubescent or glabrescent, hairs as on twigs; leaf blade (4) 7 - 11.5 (14) cm long, (1.5) 2.5 - 4.5 (5.5) cm wide, elliptic to ovate, less frequent lanceolate, apex acute to long acuminate, base rounded, obtuse, or acute, sparsely pubescent above when young but soon glabrous, sparsely and inconspicuously pubescent or glabrous below, hairs in both cases as on twigs, triplinerved, subtriplinerved or rarely penninerved, midvein flat to slightly sunken above, pubescent first, soon glabrescent, raised below, pubescent or glabrous, secondary veins (4) 5 -7 pairs, flat above, glabrous, slightly raised below, sparsely pubescent or glabrous, tertiary veins flat above, slightly raised below, glabrous, minor reticulation slightly raised, primary domatia usually present, at least one of the basal ones, but often several leaves without them, secondary domatia absent; inflorescence (2) 4 - 9 (12) cm long, axillary to leaves, cymose-paniculate, sometimes with foliose bracts at main branchings, peduncle (1) 2.5 - 5.5 (7.5) cm long, sparsely pubescent, rachis sparsely pubescent or glabrous, hairs appressed, flower pedicel (3) 4 - 6.5 (8) cm long, glabrescent or glabrous; flower narrow campanulate or urceolate, pale greenish white, greenish yellow, or yellowish white, tepals 2.2 - 2.7 mm long, 1.6 - 2.2 mm wide, ovate to widely ovate, glabrous outside, or inner tepals sparsely pubescent, sericeous inside, red hairs present, stamens of whorls I & II 1.7 - 2 mm long, filament sericeous or glabrous ad and abaxially, anthers 0.9 - 1.1 mm long, glabrous adaxially, sparsely sericeous on connective base or

glabrous abaxially, sporangia four, stamens of whorl III 1.7 - 2.1 mm long, filament sericeous adaxially, red hairs present, sericeous on lower half abaxially, sometimes glabrescent both ad and abaxially, anthers 0.8 - 1 mm long, sericeous adaxially, mainly on lower half, red hairs present, sporangia four, glands ca. 0.5 mm long, just above filament base, sericeous adaxially, red hairs present, staminode 1 - 1.2 mm long, filament sericeous ad and abaxially, sometimes only towards the margins, red hairs present adaxially, head 0.6 - 0.8 mm long, trullate in outline, slightly sericeous on base adaxially, sericeous abaxially or glabrescent, hypanthium ca. 0.5 mm deep, glabrous or glabrescent outside, densely pubescent inside, mostly red hairs present, sometimes only strips of hairs coming down from whorl stamens III and staminode bases, pistil 2.2 - 2.8 mm long, glabrous, ovary 1.1 - 1.4 mm long, 0.8 - 1.1 mm wide; fruit 15 - 22 mm long, 8 - 12 mm wide, ellipsoid, cupule 7 - 10 mm long, 6 - 7 mm wide, pedicel 1 - 4.5 mm long, 1.5 - 2 mm wide, tepals persistent.

Flowers from March to August. Fruits ripe in April and May, immature in August. The vegetation types where this species grows are temperate mixed forest, riparian forest, deciduous forest, cloud forest; between 2150 - 2800 m of altitude. East facing slopes of mountain ranges in southern Mexico (Oaxaca and Chiapas) constitute the area of distribution for this species.

That *C. areolatum* is really a distinct species from the variable *C. triplinerve* is still open to confirmation. So far, the combined characters of twigs ridged, along with distinct and raised minor reticulation on lower leaf surface, work well to separate this species most of the times. Sometimes though, specimens that overlap to some extent with *C. triplinerve* are found, e.g: *R. Torres 2687*, *R. Torres 2696*, and *R. Torres 8455*.

Specimens examined. MEXICO. **Chiapas**. Tres Cruces, Sierra Madre, *E. Matuda 5017* (MO); Jaltenango, Reserva de la biosfera "El Triunfo", aprox. 1 km al NE del campamento El Triunfo, sobre el sendero a Finca Prusia, *F. Lorea 5524* (FCME (9 dups)). **Oaxaca**.16 km al SE de Totontepec, Distrito Mixe, *M. Sousa et al. 7876* (NY (2 sheets)); 5.2 km al NE de la desviación a Zacatepec, Distr. Mixe, *R. Torres C. & R. Cedillo T. 2687* (MEXU (2 dups)); Totontepec, Dto. Mixe, 13 km al O de Totontepec, carr. a Villa Alta, *R. Torres C. & E. Ramírez 8455* (MEXU); Totontepec, Dto. Mixe, 19.5 km al SO de Totontepec carr. a Mitla, *R. Torres C. 12099* (MEXU); 7 km al NE de la desviación a Zacatepec. Dto. Mixe, *R. Torres C. & R. Cedillo T. 2696* (MEXU (2 dups)); 4 km al N del entronque Mixisistlan a Totontepec, sobre el camino a San Andrés Yaa., *R. Torres C. et al. 481* (F, MEXU, MO); Vicinity of Cerro Zempoaltepetl, in *Persea* cloud-forest at Patio de Arena, about 5 km E of summit, *B. Hallberg 876* (MEXU); Vicinity of Cerro Zempoaltepetl, in *Persea* cloud-forest at Patio de Arena, about 5 km E of summit, *B. Hallberg 877* (MEXU, NY); Totontepec, Dto. Mixe; ca. 1 km N of road between Ayutla and Totontepec on turnoff to Villa Alta, near base of foot trail on W side of hill, *R. Gereau et al. 2097* (MO (4 dups)). EL SALVADOR. **Chalatenango**. East side of Los Esesmiles, *J.M. Tucker s.n.* (NY). **Santa Ana**. Montecristo, *R. Martinez MLR 1087* (NY); Montecristo, Los Planes, *M.L. Reyna 1405* (MO); Montecristo, *A. Molina & A.R. Molina 12651* (F (2 sheets)); Montecristo, *M.L. Reyna 861* (NY); near the road to Cerro Montecristo, *M.L. Reyna 1296* (F).

Cinnamomum bractefoliaceum Lorea-Hernández, sp.nov. TYPE: Mexico. Querétaro: Mpo. Jalpan, aprox 4-5 km W to La Parada, 1400 m, tree 4-6 m. 23 April 1990 (fl) *B. Servín 141* (holotype, IEB; isotype, MO).

Arbores vel frutices. Folia ovata vel lanceolata, apice acutato ad longe acuminato, triplinervia aut subtriplinrvia, infra plus minusve pubescentia trichomatibus undulatis, adpressis; domatiis praesentibus ad axillas nonnullas venarum secundariarum et tertiariarum, pagina foliari utrinque ad domatia subplana. Inflorescentia ex cymis in paniculam aggregatis constans, plerumque bracteas foliaceas satis persistentes gerens. Flos tepalis extus sicut pedicello glabris vel sparsium pubescentibus, hypanthio intus saltem pro dimidio inferno glabrato; tepalis integris in fructu persistentibus.

Trees 4 - 6 (10) m, or shrubs 2 - 3 m tall; twigs tomentose or velutinous, hairs 0.15 - 0.25 mm long, wavy or curly, appressed, sometimes erect and up to 0.8 mm long; petiole (5) 7.5 - 12 (16.5) mm long, tomentose; leaf blade (2) 5.5 - 10.5 (15) cm long, and (1.2) 2.5 - 4 (5.5) cm wide, ovate to lanceolate, few times elliptic, apex acute to long acuminate, base rounded to acute, often oblicuous, upper surface sparsely tomentose to glabrous with aging, lower surface tomentose to glabrescent, hairs wavy to curly, appressed; venation triplinerved or subtriplinerved, with 3 -5 (7) pairs of secondary veins, slightly marked on upper surface, raised on lower surface, tomentose to glabrescent on lower surface; primary domatia present in all axils of secondary veins, secondary domatia usually present in several axils of tertiary veins; inflorescence (3.5) 5 - 9.5 (11.5) cm long, axillary to leaves, sometimes clustered on the tips of twigs, very often with foliose bracts rather persistent, cymose-paniculate, villous to sparsely tomentose, flower pedicel 4 - 6.5 (8.5) mm long, tomentose or glabrous; flowers ca. 2.5 mm long, narrowly campanulate to urceolate, greenish yellow, tepals 2.1 - 1.7 mm long, and 1.5 - 2 mm wide, ovate to widely ovate, glabrous or sparsely tomentose outside, sericeous inside,

stamens of whorls I & II 1.3 - 1.8 mm long, their filaments pubescent ad and abaxially, anthers glabrous, stamens of whorl III 1.3 - 1.8 mm long, their filaments densely sericeous to glabrescent abaxially, glabrous adaxially, anthers glabrous, sporangia four in all stamens, glands ca. 0.5 mm long, rounded to elliptic, staminodes 0.9 - 1.1 mm long, filaments glabrous or sericeous apically on adaxial face, sericeous abaxially mainly on the margins, apex totally glabrous or pilose on the base abaxially, hypanthium 0.3 - 0.5 mm deep, sparsely tomentose or glabrous outside, glabrous or very sparsely pubescent inside, ovary and style glabrous; fruit 11.5 - 15.5 mm long, and 9 - 11.5 mm wide, ellipsoid, seated on the persistent tepals, pedicel turbinate, reddish.

This species grows mainly in oak and pine forest, but it has been found also in deciduous mixed forest, between 1000 - 1800 m, in a small area of northeastern Mexico. Flowers are produced during April and May (July), and fruits mature from July through September.

Paratypes. MEXICO. **Querétaro**: Mpo. Jalpan, 4 -5 km S of La Parada, 1350 m, tree 6-8 m (fl) *B. Servín 168* (IEB, MO); Mpo. Jalpan, 3-4 km NE of El Saucito, 1150 m, tree 6-8 m (fr) *B. Servín 220* (IEB, MO); Mpo. Jalpan, Cerro Los Fresnos, 2 km N of trail to El Carrizal, 1500 m, tree 5 m (fr) *C. Guzmán 125* (IEB, MO); Mpo. Jalpan, 3-4 km N of La Parada, 1300 m, shrub 2-3 m (fr) *B. Servín 366* (IEB, MO); Mpo. Jalpan, Cerro El Pilón, S of La Parada, 1200 m, shrub 2 m (fr) *C. Guzmán 58* (IEB). **San Luis Potosí**. Mpo. 82 km W of Ciudad Valles on highway to Rio Verde, 1400 m, tree 4 m (fr) *P. Fryxell 3783* (ENCB, F, MO, NY); Mpo. 16-18 km NE of Ciudad del Maíz, 1400-1600 m, tree (fl) *R. McVaugh 10443* (NY). **Tamaulipas**. Mpo. Gómez Farías, Rancho del Cielo, 1000 m, shrub 4 m (fl) *A Gómez-Pompa 2039* (MEXU); Mpo. Gómez

Farías, Rancho del Cielo, near El Limón, (fr) *A. Sharp et al.* 52035 (MEXU); Mpo. Gómez Farías, El Paraíso, 7 km W of Rancho del Cielo, 1800 m, *F. G. Medrano et al. 7497*. (MEXU, MO).

Morphological affinity of *C. bractefoliaceum* is with *C. effusum* by the presence of secondary domatia and persistent tepals in the fruit. However, the indument on the lower leaf surface is very different between the two species; absent or made of straight and appressed trichomes in *C. effusum*, whereas always present and made of wavy to curly appressed hairs more or less persistent in *C. bractefoliaceum*. The presence of foliaceous rather persistent bracts in the inflorescence is also distinctive for *C. bractefoliaceum*, and from that feature derives the name of the species. Foliaceous bracts in *C. effusum* are rarely present, and then are poorly developed and soon deciduous.

Cinnamomum breedlovei (Lundell) Kostermans, Reinwardtia 10: 442. 1988.

Phoebe breedlovei Lundell, Wrightia 5: 431. 1977. Type. Mexico. Chiapas: Mpo. Pueblo Nuevo de Solistahuacán, ridge above Pueblo Nuevo de Solistahuacán, 15 August 1967, *A. Shilom Ton 2812* (holotype, LL!; isotypes, ENCB!, MICH!, NY!).

Trees 8 - 30 m tall; twigs densely pubescent, hairs 0.05 - 0.15 mm long, rather straight, spreading to almost appressed, white furfuraceous patches intermixed with hairs, accumulating here and there, sometimes densely so, usually very conspicuous near terminal buds, hairs rather

persistent, wax often dissapearing with age; petioles (10) 15.5 - 27.5 (35) mm long, (1) 1.5 - 2 mm wide, densely pubescent and furfuraceous as twigs, turning glabrescent with age; leaf blades (5) 10 - 17 (22) cm long, (1.5) 4 - 7 (8.5) cm wide, obovate or elliptic, apex acuminate, base acute, pubescent when young above, soon glabrous, dense but inconspicuously pubescent below, hairs as on twigs, sometimes waxy spots present early, glabrescent with age in some areas or most of surface, triplinerved or less frequently subtriplinerved, midvein sunken and glabrous above, strongly raised below, pubescent, hairs appressed, secondary veins 4 -6 pairs, lowest pair sunken above, glabrous, strongly raised below, pubescent to glabrescent, other pairs slightly sunken above, raised below, glabrescent, tertiary veins mostly perpendicular to secondaries, marked to inconspicuous above, slightly raised but inconspicuous below, primary domatia present in most of secondaries axiles, secondary domatia usually present in several tertiaries axiles; inflorescence (10.5) 14 - 20.5 (24) cm long, axillary to leaves, at base of terminal shoots and then axillary to small deciduous bracts, or terminal (?), cymose-paniculate, foliose bracts often present, peduncle (0.2) 2 - 7.5 (9.5) cm long, or absent, densely pubescent, rachis densely pubescent, glabrescent with age, flower pedicel 3 - 5 (6.5) mm long, glabrescent or glabrous; flowers urceolate, yellowish or whitish, tepals 2 - 2.6 mm long, 1.5 - 2.1 mm wide, ovate to widely ovate, sparsely pubescent ot glabrous outside, sericeous inside, sometimes outer ones sparsely so, few red hairs sometimes present, stamens of whorls I & II 1.5 - 1.9 mm long, filaments sparsely sericeous to glabrous abaxially, mainly on lower half and median section, sparsely sericeous or glabrous adaxially, anthers 0.8 - 1.1 mm lomg, glabrous ab and adaxially, sporangia four, stamens of whorl III 1.5 - 2 mm long, sericeous along lower median section abaxially, sparsely sericeo-pilose adaxially, anthers 0.6 - 0.9 mm long, glabrous abaxially,

sparsely sericeo-pilose adaxially on lower half, sporangia four, glands 0.4 - 0.5 mm long, on lower third of filament or just above the base, glabrous abaxially, sparsely sericeous adaxially at point of attachment, staminodes 0.8 - 1 mm long, pedicel sericeo-pilose abaxially, specially along the margins, glabrous or sparsely sericeous adaxially on upper half, head 0.5 - 0.7 mm long, ovate- triangular in outline, glabrous ad and abaxially, hypanthium 0.5 mm deep, glabrescent or glabrous outside, rather glabrous inside, hairs sericeous, in bands or patches coming from staminodes margins, pistil 1.8 - 2.1 mm long, glabrous, ovary 0.8 - 1 mm long, 0.8 - 1 mm wide; fruit 12.5 - 14 mm long, 8 - 9 mm wide, ellipsoid, cupule 8 - 9 mm long, 6.5 - 7 mm wide, pedicel 3 - 5.5 mm long, 1 - 1.2 mm wide, tepals wholly persistent.

Flowers are present in June and August, and fruits are found from October (young) to April. This species is one of the elements that make the tall tree layer in montane mixed forest in southern Mexico, between 1500 - 2000 m of altitude.

The almost strictly triplinerved leaves with strongly raised veins on lower surface, along with the presence of waxy particles on young stems and leaves, are distinctive for *C. breedlovei*. These characters also help to separate this species from *C. bractefoliaceum* and *C. effusum*, the other two species with secondary domatia occuring in the same general area.

Specimens examined. MEXICO. **Chiapas**. Pueblo Nuevo Solistahuacán, along the ridge above Pueblo Nuevo Solistahuacán., *A. Shilom Ton 2812* (LL, NY, ENCB); Rayón, steep moist slope near Puerto del Viento, 9 m NW of Pueblo Nuevo Solistahuacán along rd to Tapuila, *D. E. Breedlove 11975* (ENCB). **Oaxaca**. Comaltepec, Ixtlán, 7km al S de Vista Hermosa, carr.

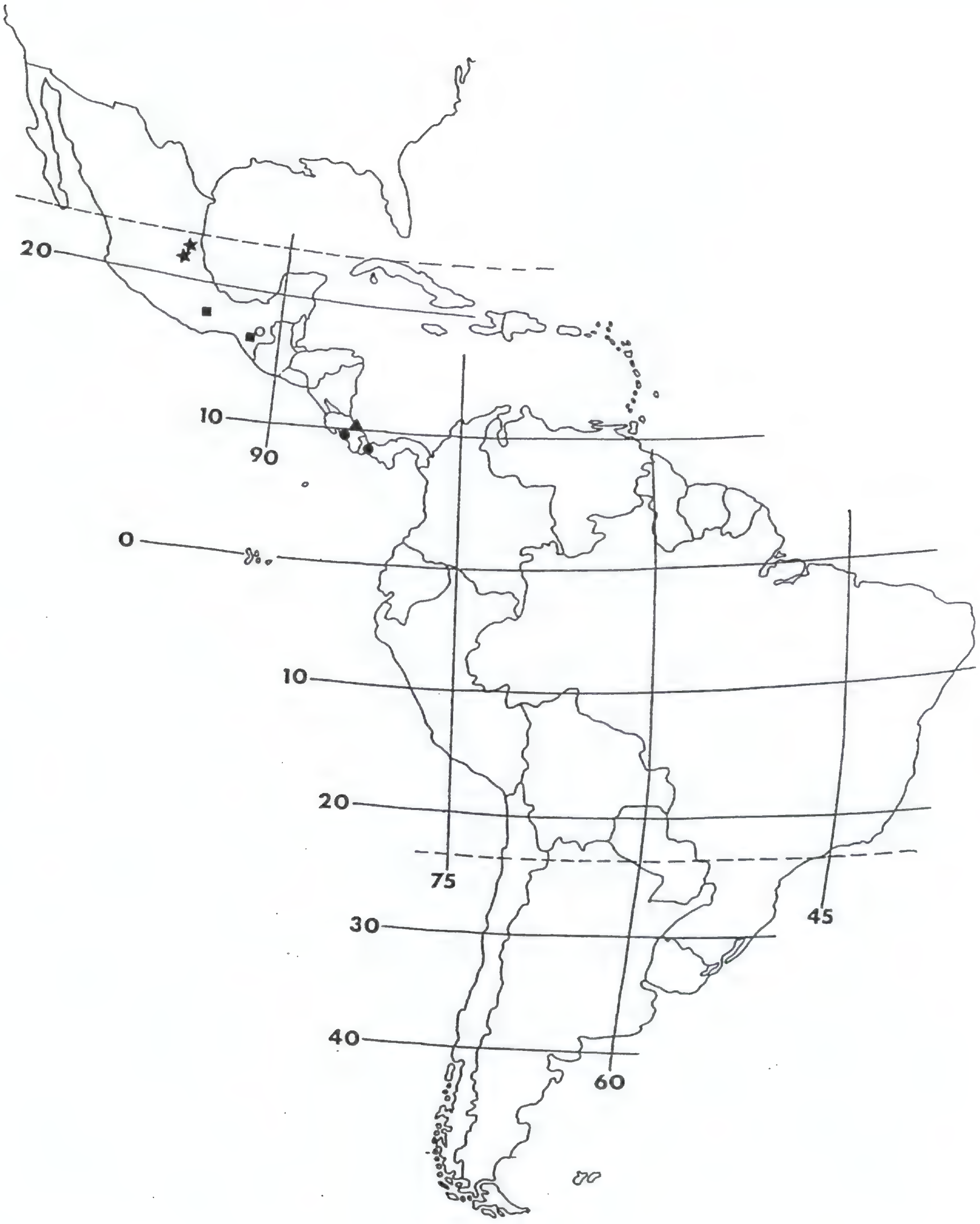


Figure 5. Known distribution of (★) *C. bractefoliaceum*, (■ *C. breedlovei*, (●) *C. brenesii*, (▲) *C. chavarrianum*, and (○) *C. chiapense*.

Tuxtepec-Oaxaca, *R. Torres 8749* (MEXU, MO (2 dups)); Tuxtepec rd., near Ranchería Tarabundi, *C.K. Allen 108* (NY(4 sheets)); Comaltepec, Ixtlán, *R. López L. & G. Martin 693* (MO).

Cinnamomum brenesii (Standley) Kostermans, Reinwardtia 6: 20. 1961.

Phoebe brenesii Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 18: 459. 1937. Type. Costa Rica. Alajuela: Entre San Miguel y La Palma de San Ramón, 14 February 1933, *E. Brenes 17048* (holotype, F!; isotype, NY!).

Trees 5 - 15 (25) m, or shrubs (?) 2 m tall; twigs tomentose, glabrescent with age, hairs 0.2 (0.3) mm long, wavy, spreading or erect, matted when dense; petioles (8) 13 - 23 (32) mm long, 0.6 - 1 (1.2) mm wide, tomentose when young, soon glabrescent, hairs as on twigs; leaf blades (3) 5 - 9 (12) cm long, (1.5) 2.5 - 4 (5) cm wide, elliptic or ovate, rarely obovate, apex acuminate, base rounded to acute, shortly attenuate, sparsely pubescent when young above, soon glabrous, sparsely pubescent below, glabrescent or glabrous with age, hairs as on twigs, triplinerved or subtriplinerved, midvein slightly marked above, glabrous, raised below, glabrescent or glabrous, secondary veins 4 - 5 pairs, lowest pair distinct but flat above, slightly raised below, glabrous, other pairs distinct and flat above, almost flat below, tertiary veins often inconspicuous above and below, primary domatia present, often only the lowest pair, secondary domatia absent; inflorescence (3.5) 5.5 - 13 (16) cm long, axillary to leaves or at the base of new shoots and axillary to small deciduous bracts, cymose-paniculate, foliose bracts often present at

main divisions, sometimes as big as normal leaves, peduncle (1.5) 3 - 6 (7) cm long, sparsely pubescent to glabrescent, rachis glabrescent or glabrous, flower pedicel glabrous; flowers (oblong) urceolate, tepals 2.2 - 2.8 mm long, 1.3 - 1.8 mm wide, elliptic to ovate, outer ones glabrous outside, inner tepals pubescent outside, all sericeous inside, stamens of whorls I & II 1.7 - 2.1 mm long, filaments sparsely pubescent or glabrescent along median section adaxially, sparsely sericeo-pilose abaxially, anthers 1 - 1.2 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 1.8 - 2.2 mm long, filaments sericeo-pilose ad and abaxially, few red hairs sometimes present adaxially, anthers 0.8 - 1 mm long, glabrous abaxially, sparsely pubescent on lower half adaxially, sporangia four, glands 0.6 - 0.8 mm long, at base of filament, glabrous abaxially, sericeous adaxially along median section, staminodes 0.9 - 1.6 mm long, pedicel densely sericeo-pilose abaxially, glabrous or sericeous on upper half adaxially, some red hairs present, head 0.6 - 0.9 mm long, cordate in outline, acuminate, sericeo-pilose to glabrescent abaxially, glabrous adaxially, hypanthium ca. 0.5 mm deep, glabrous outside, glabrescent to densely sericeous inside, pistil 2.1 - 2.6 mm long, glabrous, ovary 0.9 - 1.2 mm long, 0.7 - 1 mm wide; fruit 8.5 - 11.5 mm long, 4.5 - 7 mm wide, ellipsoid, cupule 3.5 - 7 mm long, 4 - 5 mm wide, pedicel 2 - 3 mm long, 0.9 - 1.1 mm wide, tepals partially persistent, articulate below the middle.

Flowers present in January-February, and April. Fruits ripe in June, but can be found in April-May. Montane forests, between (100) 700 - 1200 m, constitute the habitat of this species.Geografic distribution goes from central Costa Rica to western Panama.

C. brenesii is not too far morphologically from *C. triplinerve*, but the relatively long

petioles, coupled with light green-glaucous lower leaf surface, and partially persistent tepals, make this entity distinct enough to be recognized as different from the variable *C. triplinerve*.

Specimens examined. COSTA RICA. **Alajuela**. entre San Miguel y La Palma de San Ramón, *A. M. Brenes 17048* (F, NY, A); La Palma de San Ramón, *A. M. Brenes 6810* (F, NY); "San Pedro", cerca de San Francisco de San Ramón, *A. M. Brenes 6675* (); near San Ramón, *A. M. Brenes 4896* (NY, F); near San Ramón, *A. M. Brenes 5518* (F). **Guanacaste**. Cantón de Abangares, Cordillera de Tilaran, La Sierra Candelaria, *E. Bello 4983* (MO); Cantón de Sta.Cruz, Península de Nicoya.Vista de Mar, al sur de Sta.Cruz, *C. Guindon & D.Brenes 55* (MO). **Puntarenas**. Cantón de Puntarenas, Monteverde, Cordillera de Tilaran, San Luis, 2km del cruce a Sta. Elena, *J. F. Morales 2437* (MO); Cantón de Puntarenas, Monteverde, Cordillera de Tilarán, de Sta. Elena por el camino viejo hacia La Cruz, por entrada a potreros, *C. Guindon & D.Brenes 21* (MO); Costa Rica. Puntarenas: , Zapotal, Montes de Oro, Q. Jiménez L. s.n. (F). **San José**. Ciudad Colón, en un potrero, *L. Poveda et al. 3399* (F); Río Paca, Finca Tablera, Villa Colón, *A. Jiménez M. 3868* (S, F, MO); Cantón de Acosta, Cerros de Escazú, Agua Blanca, Alto El Guabal, por quebrada Mina, *J. F. Morales & M. Barrantes 2373* (MO); Vicinity of Villa Colón, *R. K. Godfrey 66486* (MO); without precise locality, *H. Pittier 16392* (G). PANAMA. **Chiriquí**.Bogueli District, *M. E. Davidson 641* (W); Distrito de Montijo, Isla Coibo, sendero desde Est.Biol. hacia Ensenada Santa Cruz, *C. Galdames et al. 2232* (MO).

Cinnamomum chavarrianum (Hammel) Kostermans, Reinwardtia 10: 442. 1988.

Phoebe chavarriana Hammel, J. Arnold Arb. 67: 131. 1986. Type. Costa Rica. Heredia: Finca La Selva, on Río Puerto Viejo just E of its junction with Río Sarapiquí, 2 May 1982, *Hammel 11931* (holotype, DUKE n.v; isotypes, F!, MO!, NY!).

Trees 7 - 15 m tall; twigs densely tomentulose, hairs ca. 0.1 mm long, straight, appressed, becoming sparse with age; petioles (23) 30 - 44 (50) mm long, (2.4) 2.8 - 3.8 mm wide, inconspicuously tomentulose, hairs as on twigs, glabrescent with age; leaf blades (27) 30 - 39 (45) cm long, (10) 13 - 21.5 cm wide, elliptic, narrowly elliptic or ovate, apex acute to acuminate, base obtuse, or rounded, less frequently acute, glabrous above, sparsely and inconspicuously tomentulose below or glabrous, pinninerved, midvein strongly impressed to sunken above, glabrous, strongly raised below, sparsely tomentulose (along the margins), secondary veins 9 - 11 pairs, flat or slightly impressed above, glabrous, raised below, sparsely tomentulose, tertiary veins flat above, glabrous, almost flat below, domatia absent; inflorescence (7) 11.5 - 18 (20.5) cm long, axillary to leaves (or to deciduous bracts), single or clustered on very short axillary branches, cymose-panicualte, peduncle (0.4) 3 - 8.5 (9.5) cm long, puberulent, rachis puberulent, flower pedicel (2.5) 3 - 4 (4.6) mm long, glabrous or sparsely puberulent; flowers greenish or yellowish white, urceolate, tepals 2 - 2.8 mm long, 1.6 - 2.4 mm wide, ovate or widely ovate, tomentulose outside, the external ones sparsely so, the external ones glabrous or glabrescent inside, inner ones sericeous inside, stamens of whorls I & II ca. 1.9 mm long, filaments sparsley tomentulose adaxially, tomentulose abaxially, anthers ca. 1.1 mm long, glabrous adaxially and abaxially, or sparsely tomentulose at the base on median section, sporangia four, introrse, stamens of whorl III ca. 1.9 mm long, fialments sericeo-villose

adaxially, sericeous abaxially, red trichomes present, anthers ca. 0.9 mm long, sericeo-villose at base adaxially, glabrous abaxially, sporangia four, upper ones latrorse, lower ones extrorse, glands ca. 0.6 mm long, above filament base, glabrous except for point of attachement adaxially, staminodes 1.2 - 1.4 mm long, filament sericeo-villose ad and abaxially, red trichomes abundant, head 0.8 - 1 mm long, triangular cordate, glabrous adaxially, sericeo-villose abaxially, sometimes sparsely so at upper half, hypanthium ca. 0.6 mm deep, glabrous or glabrescent outside, sericeous inside (sometimes in patches), red hairs abundant or scarse, pistil 2.1 - 2.3 mm long, glabrous, ovary 1 - 1.2 mm long, 0.9 - 1.1 mm wide; fruit 13.5 mm long, 10 mm wide, ellipsoid, cupule 9 - 10 mm long, 7.5 mm wide above, 2.6 mm wide at the bottom, pedicel indistinct, tepals persistent.

Flowers present in April and May. Ripe fruits present from August to September. No information about the type of vegetation where this species grows has been recorded, but it is suspected to be tropical rain forest, given the region where it has been collected. Altitudinal range is rather narrow, from 100 to 200 m. So far *C. chavarrianum* is known only from a very small area in central Costa Rica.

This species is easily recognized on the basis of having leaves pinninerved lacking domatia, and fruits with persistent tepals.

Specimens examined. COSTA RICA.Costa Rica. **Alajuela**. San Rafael de Guatuso, faldas del Volcán Tenorio, *M. M. Chavarría et al. 236* (MO). **Heredia**. Finca La Selva, the OTS Field Station on the Río Puerto Viejo just E of its juction with the Río Sarapiquí, *B. Hammel*

11931 (MO, NY, F); edge of Río Peje, *B. Hammel 11679* (F); Finca La Selva, the OTS field station on the Río Puerto Viejo just E of its junction with the Río Sarapiquí, *M. H. Grayum 2767* (MO); Parque Nacional Braulio Carrillo, Estación Magsasay. Sarapiquí., *R. Aguilar 158* (MO); Finca La Selva, the OTS field station on the Río Puerto Viejo just E of its junction with the Río Sarapiquí, *B. Hammel & J. Trainer 12922* (MO, F); Finca La Selva, Puerto Viejo, Sarapiquí, *G. Hartshorn 1179* (MO); Sarapiquí, Parque Nacional Braulio Carrillo, Llanura de San Carlos, Río Peje, Estación Magsasay, *A. Fernández 389* (MO). **Limón**. Reserva Indígena Talamanca, camino a Soki entre la quebrada Amubri, margen izquierda de Río Lari, *A. Chacón 13* (MO).

Cinnamomum chiapense (Lundell) Kostermans, Reinwardtia 6: 20. 1961.

Phoebe chiapensis Lundell, Contr. Univ. Michigan Herb. 6: 21. 1941. Type. Mexico. Chiapas: Acacoyahua, Mt. Ovando, December 1937, *E. Matuda 2064* (holotype, MICH!; isotypes, A!, F!, LL!, MO!, NY!).

Trees or shrubs 2 - 8 m tall; twigs reddish brown, appressed pilose close to the terminal bud, otherwise glabrous, hairs 0.1 - 0.2 mm long; petioles (3) 5.5 - 8 (9.5) mm long, (0.5) 0.6 - 0.9 (1.2) mm wide, canaliculate, scattered appressed pilose when young or glabrous; leaf blades (4) 6.5 - 10.5 (12.5) cm long, (0.9) 1.2 - 2 (2.5) cm wide, narrowly elliptic or lanceolate, apex long acuminate, sometimes slightly falcate, base acuminate, glabrous above and below, very sparsely appressed pilose when young, mostly pinninerved, sometimes subtriplinerved or triplinerved, midvein flat to slightly convex above, glabrous, slightly raised below, glabrous or

with scattered appressed hairs, secondary veins 5 - 8 (10) pairs, glabrous, tertiary veins slightly raised, domatia absent; inflorescence 2.5 - 5.5 cm long, axillary to leaves, cymose, very simple, only with one to three dichasia, peduncle 2 - 3.8 cm long, glabrous or sparsely puberulous, flower pedicel (4) 5 - 7.5 (9) mm long, glabrous; flower urceolate, pale greenish yellow, tepals 1.8 - 2.1 mm long, 1.7 - 2 mm wide, ovate to widely ovate, glabrous outside, rarely the inner ones sparsely pubescent, sericeous inside, some red hairs present at tepal base, stamens of whorls I & II 1.1 - 1.6 mm long, filaments densely sericeous adaxially and abaxially, some red hairs present adaxially, anthers 0.8 - 1.0 mm long, sparsely sericeous on the connective and anther base abaxially, sporangia four, stamens of whorl III 1.3 - 1.6 mm long, filaments densely sericeous ad and abaxially, usually red hairs present on lower half adaxially, anthers 0.7 - 1 mm long, sparsely sericeous adaxially on connective and base margin, sporangia four, glands 0.3 - 0.5 mm long, at base of filament, sericeous adaxially, staminode 0.7 - 1.1 mm long, pedicel densely sericeous ad and abaxially, red hairs mostly covering adaxial face, head 0.4 - 0.8 mm long, ovate trullate in outline, glabrous or long sericeous at central area abaxially, hypanthium ca. 0.5 mm deep, glabrous outside, densely pubescent inside, with red hairs present, sometimes covering the whole surface, pistil 1.6 -2.1 mm long, glabrous, ovary 0.8 - 1 mm long, ca. 0.8 mm wide; fruit 11.5 - 12.5 mm long, 7.5 - 9 mm wide, ellipsoid, cupule 6 - 8.5 mm long, 5 - 5.5 mm wide, pedicel absent, or 2.5 - 3.5 mm long, 0.8 - 1 mm wide, tepals persistent, lower third or half fleshy.

Flowers in December and April. Fruits in April. In pine-juniper forest, between 1750 - 1800 m. This species is only known from a small area in the central highlands of the state of

Chiapas in Mexico.

C. chiapensis is a very peculiar species in the group of neotropical *Cinnamomum* species; its narrow thick mostly pinninerved leaves coupled with the absence of domatia and pauciflorous inflorescences are distinctive features for this species.

Specimens examined. MEXICO. **Chiapas**. Mt. Ovando, *E. Matuda 2064* (MO(2 sheets), F, LL(2 sheets), A, MICH, NY, U); Jaltenango, Reserva de la Biosfera "El Triunfo", aprox. 3 km al SE del campamento El Triunfo, sobre el sendero a Tres de Mayo, *F. Lorea 5525* (FCME (8 dups)); Escuintta, *E. Matuda 429* (MEXU).

Cinnamomum concinnum Lorea-Hernández, nom. nov.

Phoebe elegans van der Werff, Ann. Missouri Bot. Gard. 75: 415. 1988. Type. Mexico. Oaxaca: San Miguel Chimalapa, cima del Cerro Salomón, 11 April, 1986. *M. Ishiki 1501* (holotype, MO!; isotypes, CHAPA, n.v., HBG, n.v., LL, n.v., MEXU, n.v., MO!). *Cinnamomum elegans* Reinecke, Bot. Jahrb. Syst. 25: 633. 1898., prevents the use of the epithet "elegans" for this species.

Trees 3 -5 m tall; twigs glabrous; petiole (8.5) 11 - 18 (20.5) mm long, (0.3) 0.4- 0.8 (1) mm wide, glabrous; leaf blade (2.5) 4.5 - 8 (9.5) cm long, (1) 2 - 3 (3.5) cm wide, ovate, rarely lanceolate, apex long acuminate or less acuminate, base rounded or truncate, often oblique, glabrous on both sides, trinerved or triplinerved, midvein flat above, slightly elevated below,

glabrous, secondary veins 3 - 4, flat above and below but distinct, glabrous, tertiary veins flat, glabrous, domatia absent; inflorescence 2.5 - 4.5 cm long, axillary to leaves, cymose, just one or two branchings, pauciflorous, peduncle 1.5 - 3 cm long, glabrous, rachis glabrous, flower pedicel (8) 9.5 - 12.5 mm long, glabrous; flower urceolate or slightly campanulate, greenish (?), tepals 2.2 - 2.4 mm long, 1.6 - 2 mm wide, widely ovate, glabrous outside, sericeous inside, red hairs present, stamens of whorls I & II ca. 1.1 mm long, filament as wide as anther, sericeous ad and abaxially, red hairs present, anthers 0.6 mm long, quadrangular, glabrous, sporangia four, stamens of whorl III ca. 1.3 mm long, filament wider than anthers, sericeous on margins, sometimes red sericeous abaxially, anthers ca. 0.6 mm long, glabrous, sporangia four, glands absent, staminode 0.7 - 0.8 mm long, filament sparsely sericeous on margins, sometimes also abaxially, head ca. 0.5 mm long, slightly trullate or ovate in outline, not much wider than filament, glabrous, hypanthium ca. 0.5 mm deep, glabrous outside and inside, or with some red hairs coming down from III whorl stamens and staminodes bases, pistil 1.8 - 1.9 mm long, glabrous, ovary ca. 1 mm long and wide; fruit (maybe not ripe) 8 - 8.5 mm long, 6 - 6.5 mm wide, ellipsoid, cupule 4 - 5 mm long, 3.5 mm wide, pedicel 1.5 - 4.5 mm long, 0.6 - 0.7 mm wide, tepals persistent.

Flowers and fruits present in April. Vegetation type: elfin forest (cloud forest) at 1770 m of altitude. So far *C. concinnum* is known only from the type locality, a low mountain in the Isthmus of Tehuantepec, Oaxaca.

Placement of this species in *Cinnamomum* is provisional. The characters that distinguish it from the rest of species in the area are really singular in the group (even for the Lauraceae as a

whole), i.e. filaments thick and as wide or wider than anthers, and the absence of glands. On the other hand, however, the trinerved to triplinerved leaves, flowers with tepals sericeous inside, and persistent in the fruit, suggest a close relation to *Cinnamomum*. Actually, glands might be not absent after all, for the thick stamens of whorl III may be the result of their fusion with the filaments.

Specimens examined. MEXICO. **Oaxaca**. San Miguel Chimalpa, Cima del Cerro Salomón, al NO de Benito Juárez, ca. 44 km en línea recta al N de San Pedro Tapanatepec, *M. Ishiki 1501* (MO); San Miguel Chimalapa, Cima del Cerro Salomón, al NO de Benito Juárez, ca. 44 km en línea recta al N de San Pedro Tapanatepec, *M. Ishiki 1529* (MO); San Miguel Chimalapa, Cima del Cerro Salomón, al NO de Benito Juárez, ca. 44 km en línea recta al N de San Pedro Tapanatepec, *M. Ishiki 1616* (MO); San Miguel Chimalapa, Cima del Cerro Salomón, al NO de Benito Juárez, ca. 44 km en línea recta al N de San Pedro Tapanatepec, *M. Ishiki 1454* (MO).

Cinnamomum costaricanum (Mez & Pittier) Kostermans, Reinwardtia 6: 21. 1961.

Phoebe costaricana Mez & Pittier, Bull. Herb. Boissier, ser. 2, 3: 230. 1903. Type. Costa Rica. Cañas Gordas, *Pittier 11107* (holotype, CR, n.v.; isotypes, BR!, GH!, NY!, US! (2 sheets)).

Trees 8 - 20 (30) m tall; twigs more or less flatten to terete, glabrescent, hairs 0.1 - 0.2 (0.3) mm long, straight, appressed, scattered; petiole (6) 9.5 - 16 (20.5) mm long, (0.8) 1.2 - 1.8

(2) mm wide, glabrescent, hairs asa on twigs; leaf blades (5.5) 7.5 - 13.5 (18) cm long, (1.5) 3 - 5 (7) cm wide, narrowly elliptic, apex acute to acuminate, base acute to attenuate, glabrous above and below, triplinerved or subtriplinerved, midvein slightly marked above, glabrescent or glabrous, raised below, rather glabrous, secondary veins (3) 4 - 5 (6) pairs, lowest pair sharply distinct, strongly ascending, flat above, slightly raised below, glabrous, other pairs less conspicuous, flat above, barely raised to flat below, tertiary veins flat above, flat to barely raised below, glabrous, primary domatia present, only lowest pair, sometimes absent in several leaves, secondary domatia absent; inflorescence (7) 8.5 - 15 (18) cm long, axillary to leaves, simple, or several in very short axillary racemes, cymose-paniculate, peduncle (3) 4 - 8.5 (10) cm long, sometimes almost absent, glabrous, rachis glabrous, flower pedicel (3.5) 4 - 6 (7.5) cm long, glabrous; flower narrow urceolate, tepals 1.9 - 2.4 mm long, 1.3 - 2 mm wide, ovate, glabrous outside, sericeous inside, stamens of whorls I & II 1.5 - 1.9 mm long, filaments glabrous ad and abaxially, or sparsely sericeous adaxially, anthers 0.7 - 0.9 mm long, glabrous ad and abaxially, sometimes some hairs present at base of lower sporangia, sporangia four, introrse, stamens of whorl III 1.5 - 1.9 mm long, filaments glabrous or sparsely long sericeous on upper half adaxially, glabrous or sparsely long sericeous at base abaxially, anthers 0.6 - 0.7 mm long, glabrous or sparsely long sericeous on lower half adaxially, glabrous abaxially, sporangia four, upper ones latrorse, lower ones latrorse-extrorse, glands 0.5 - 0.6 (0.7) mm long, at filament base, ovate, glabrous or with few hairs at point of attachment adaxially, staminodes 0.8 - 1.1 mm long, filaments glabrous or with few long sericeous hairs on margins and upper half adaxially, head 0.5 - 0.7 mm long, triangular or shallow cordate in outline, acuminate, glabrous ad and abaxially, hypanthium 0.4 - 0.5 mm deep, glabrous outside, glabrous inside, pistil 1.9 - 2.3 mm long,

glabrous, ovary 1.1 - 1.3 mm long, 0.8 - 1.1 mm wide; fruit 11 - 21 mm long, 8 - 11 mm wide, ellipsoid, cupule 5 - 8 mm long, 5 - 7.5 mm wide, pedicel 3 - 5 mm long, 0.9 - 1.7 mm wide, tepals persistent.

Flowering specimens have been recorded from February through April; ripe fruits can be found in December, January, February, July, and September. Natural vegetation where this species occurs include: cloud forest, premontane wet forest, and seconday forest, between 1000 - 1500 (1700) m altitude. The distribution of *C. costaricanum* includes the mountains in central Nicaragua, and eastern mountain ranges in Costa Rica and adjacent Panama.

C. costaricanum and *C. neurophyllum* are morphologically very close. Looking at sterile specimens or without fruits it is difficult to tell them apart. Here, the two species are kept distinct on the grounds of the correlation of few characters, namely the presence of persistent tepals, lowermost pair of secondaries not strongly raised, and domatia trichomes rather spreading to erect in *C. costaricanum*, and partially persistent tepals in fruit, lower most pair of secondary veins strongly raised, and domatia trichomes mostly parallel to leaf surface in *C. neurophyllum*. *C. grisebachianum* is barely different from *C. costaricanum* (see comment under that species).

Specimens examined. COSTA RICA. **Puntarenas**. Las Alturas de Coto Brus, *W. Burger et al 12190* (MO); Las Alturas de Coto Brus; ca. 20 km NE of San Vito, in forest along road 1-3 km S of Las Alturas, *B. Hammel et al. 14197* (MO); Buenos Aires, siguiendo filas en cuenca superior de Río Cabagra., *G. Herrera 3541* (MO); Cañas Gordas, *H. Pittier 11107* (GH, BR, US (2sheets), NY); Foothills of the Cordillera de Talamanca, lower montane forest in the area of

Sitio Coton / along the road to Sitio Coto Brus, *G. Davidse 24579* (MO); Zona Protectora Las Tablas, Estación Las Alturas, Las Alturas de Coto Brus, *R. Aguilar 728* (MO); Cordillera de Talamanca, area around Río Canasta, 9.5 airline km NW of Agua Caliente, between Cerro Frantzius and Cerro Pittier, *G. Davidse et al. 28505* (MO, U). **San José**. Turrubares, Cuenca del Río Grande de Tarcoles, Cerro Turrubares, faldas del cerro en la cabecera del Río Carara, *B. Hammel 18973* (MO(3 dups)). NICARAGUA. **Esteli**. El Zacatón, "El Delirio" camino a la laguna de Miraflor, *P. P. Moreno 22680* (MO); El Zacatón, *A. Laguna 330* (MO); El Chapernal, 1km al W de La Laguna de Miraflor, *P. P. Moreno 22387* (MO); Camino a cerro La Laguna, NE of Esteli, *J. Sandino 4707* (MO). **Jinotega**. Hacienda La Palestina, situada a unos 10 km al este de la ciudad de Jinotega, *A. Grijalva et al. 197* (MO, ENCB, U, VEN); Along rd. from Hwy 3 to La Fundadora, *W.D. Stevens 22545* (MO); 1 km al N de Santa Latenia, sobre carr. a Jinotega, *J. Sandino 4700* (MO, BM). **Matagalpa**. Santa Maria de Ostuma, entre el Km 139-141, *A. Grijalva et al. 3709* (ENCB, MO); Finca Sta. Maria de Ostuma, Cordillera Central de Nicaragua, *L. O. Williams et al. 27894* (MO, BM); Cerro El Picacho, *P.P. Moreno 24374* (MO); Finca Santa Maria de Ostuma, Cordillera Central de Nicaragua, *L.O. Williams & A. Molina 42583* (BM); Santa Maria de Ostuma, entre el km 139-141, *A. Grijalva & D. Soza 3713* (MO); Road to Aranjuez, Cordillera Central de Nicaragua, *L.O. Williams & A. Molina 42793* (BM). PANAMA. **Chiriquí**. Forests around El Boquete, *H. Pittier 2998* (F); Fortuna Dam, on slopes of Río Hornito to south of lake, *G. McPherson 10870* (MO (8 dups)); Vicinity of Fortuna Dam, along Tres de Noviembre trail, *G. McPherson 11097* (MO (11 dups)); Forests around El Boquete, Chiriquí, *H. Pittier 3146* (F); Bajo Mono, Boquete District, *M. E. Davidson 583* (F).

Figure 7. Known distribution of (★) *C. concinnum*, (■) *C. costaricanum*, (●) *C. effusum*, (▲) *C. erythropus*, and (○) *C. formicarium*.

Cinnamomum effusum (Meissner) Kostermans, Reinwardtia 6: 21. 1961.

Phoebe effusa Meissner, in DC. Prodr. 15: 33. 1864. Type. Mexico. Veracruz: *Linden 13, 14, 78* (syntypes, only # 78 was found in BR!, G!, MICH!).

Phoebe effusa var. *parvifolia* Meissner, in DC. Prodr. 15: 33. 1864.Type. Mexico. Veracruz: Orizaba, January 1855 *Botteri 1044* (syntypes, BM!, P!), and April 1854 *Botteri 1039* (syntypes, BM!, G!, NY!, P!).

Persea effusa (Meissner) Hemsley, Biol. Centr. Amer. III. 71. 1882.

Phoebe barbeyana Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 209. 1889. Type. Mexico. Veracruz: Orizaba, 12 May 1866 *Bourgeau 2436* (holotype, B, n.v.; isotypes, G!, K!, P!).

Trees (4) 8 - 15 (20) m, or shrubs (2) 5 - 8 m tall; twigs sparse to densely puberulo-tomentose, hairs 0.15 - 0.3 mm long, mostly appressed, straight or slightly wavy; petiole (4) 5.5 - 8.5 (11.5) mm long, puberulous, leaf blade (4) 7 - 12.5 (18) cm long, and (1.5) 2.5 - 5 (7) cm wide, elliptic, narrowly elliptic, or sometimes obovate or oblanceolate, apex acute to long acuminate, base acute to acuminate, triplinerved or subtriplinerved, with (3) 4 - 6 pairs of secondary veins, upper surface glabrous, lower surface glabrous or sometimes sparsely puberulous, hairs 0.2 - 0.5 mm long, appressed, secondary veins sparsely puberulous or glabrous underneath; primary domatia present in the axils of several secondary veins, secondary domatia present at least in one axil of a tertiary vein, but not in all leaves, sometimes absent; inflorescence (3.5) 6 - 14 (19) cm long, axillary to leaves or to small deciduous bracts, then on very short shoots and looking terminal, cymose-paniculate, terminal branchings seldom reduced,

sparsely tomentose to glabrous, often glauco-ceraceous, flower pedicel (3) 4 - 6 (7.5) mm long, glabrous; flowers 2.3 - 2.8 mm long, urceolate, white or greenish yellow, tepals 1.6 - 2.3 mm long, and 1.3 - 2.1 mm wide, ovate to widely ovate, glabrous outside, sericeous inside, stamens of whorls I & II 1 - 2 mm long, their filaments glabrous or sparsely short sericeous ad and abaxially, anthers glabrous, stamens of whorl III 1.1 - 1.8 mm long, their filaments sparsely short sericeous on the margins and abaxially, anthers glabrous, sporangia four in all stamens, glands 0.3 - 0.6 mm long, rounded or elliptic, staminodes 0.7 - 1.2 mm long, their filaments glabrous adaxially, sparsely pubescent abaxially, apex sparsely pubescent on the base abaxially, glabrous elsewhere, hypanthium 0.3 - 0.5 mm deep, glabrous outside and inside, ovary and style glabrous; fruit 9 - 13.5 mm long, and 7.5 - 10 mm wide, ellipsoid, seated on the whole persistent tepals, pedicel turbinate, reddish.

This species occurs frequently in oak, and mixed deciduous forest of the inland hills and Gulf facing slopes of the eastern Sierra Madre in Mexico, between (200) 600 - 1300 (1600) m of altitude. Although it is found also in pine forest of the same area, it is rather rare in this type of vegetation. Flowers are present from March to June, but occasionally also in September. Fruits ripe from June to August.

Of the other two species with secondary domatia (*C. bractefoliaceum*, *C. breedlovei*) in the eastern Sierra Madre *C. effusum* is easily differentiated by the absence of indument on lower leaf surface or, if present, by having only straight appressed hairs. For other distinguishing features see comments in those species.

Lectotypification of the material belonging to this species is still not possible, as *Linden*

13 and *14* collections could not be studied. For the moment it would be right to select *Linden 78* as the lectotype, since duplicates are found in other herbaria besides BR, the home herbarium of Linden collections. The presence of secondary domatia in some leaves, and glabrous lower leaf surfaces in *Bourgeau 2436* (the type collection of *Phoebe barbeyana*), along with the study of several fruiting material from the area allowed the identification of these specimens as conspecific with *Phoebe effusa*.

Specimens examined. MEXICO. **Hidalgo**. , 7 km S of Chapulhuacán along MEX 85, *R. Wunderlin et al. 1124* (MO). **Puebla**. Xicotepec de Juárez, 5 km al NE de Xicotepec, carr. a La Ceiba, *G. Toriz et al. 270* (MO). **Querétaro**: Landa, 2 km al W de Neblinas, Cañon del Río, *F. Lorea 5555* (FCME (2 sheets)); Landa, 6 km al NE de Agua Zarca, sobre el camino a Neblinas, *J. Rzedowski 46553* (IEB). **San Luis Potosí**. Tamazunchale, entre Taman y San Francisco, *J. Rzedowski 11037* (ENCB); Xilitla, Las Crucitas, *J. Rzedowski 10121* (ENCB); Xilitla, cerca de 1 km al W de Xilitlilla, *Rzedowski 10485* (ENCB). **Veracruz**. región de Orizaba, *E. Bourgeau 2436* (P, G (2 sheets), K, F); without precise locality, P. *Martens s.n.* (BR); between Veracruz and Jalapa, *J. Linden 78* (G, MICH, NY); Orizaba, *Botteri 1039* (G, NY, P, BM); Orizaba, *Botteri 1044* (P, BM); Totutla, El Mirador, *F. Ventura 14163* (ENCB); Totutla, *Liebmann 772* (C); Calipa, *Liebmann 774* (C, US); Papantla, *Liebmann 775* (C); Mirador, *Liebmann 776 a:46 b:45* (C); without precise locality, *H. Galeotti 7009* (BR, G, P); San Andrés Tuxtla, *E.W. Nelson 448* (A); Tlapacoyan, El Saral, *F. Ventura 17177* (ENCB); Papantla, Cerro del Carbón, *M. E. Cortés 269* (MEXU); Tlapacoyan, Paso Real, *F. Ventura 12825* (ENCB); Atzalan, Cochota, *F. Ventura 17294* ? (ENCB); Jalacingo, El Cuizalin, *F. Ventura 1130* (ENCB); Xalapa, Ejido

"Mártires de Chicago", *F. Ventura 10081* (ENCB); Tlapacoyan, Papatales, *F. Ventura 20360* (ENCB); Tenango, al N de Río Blanco, *R. Torres & H. Herrera 3253* (MEXU); S. Juan Coscomatepec, El Encino, *F. Ventura 4931* (ENCB (2 dups)); Mirador, *C. A. Purpus 8809* (MO); Totutla, *Liebmann 773 n.48* (MO, C); Nogales, *C. Velázquez 160* (MO, F, XAL); Xalapa, Salto de El Gato, 3km NE de Xalapa, *J. Dorantes 9* (MO, F); Texhuacán, 3 km SSW of Zongolica along gravel road to Texhuacán, *M. Nee & K. Taylor 29460* (MO); Xalapa, Bosque de Guadalupe, *A. Gentry & G. Linera 75692* (MO); Xalapa, Bosque de Guadalupe, *A. Gentry & G. Linera 75664* (MO); Mirador, *Liebmann 776 n.44* (F); Zacuapam, *C.A. Purpus 14320* (F); Orizaba, *Botteri 1734* (P); without precise locality, *Hahn s.n.* (P); El Mirador, *C.A. Purpus 14321* (C); a 2.5 km de la carr. Mex. Poza Rica, camino a Mecapalapa, *M. Martínez 107* (MEXU); Huatusco, Río Seco, 1 km al SO de la carretera Huatusco-Coscomatepec, *S. Avendaño R. & G. Castillo 501* (F); Juchique de Ferrer, alrededores de Juchique de Ferrer, camino Juchique-Plan de las Hayas, *C. Hernández 235* (F); Hacienda del Mirador, *C. A. Purpus 8334* (?); Huatusco, Tenejapa, carretera Huatusco-Coscomatepec, *S. Avendaño & R. V. Ortega 267* (F); San Andrés Tenexapa, *G. Medrano 1589* (MEXU); Rancho Remudadero, *C. A. Purpus 11163* (F); Zacuapam, *C. A. Purpus 14004* (F); Mirador, *Liebmann 776 a:51 & a:49* (C); Totutla, *Liebmann n.47* (P); Ixhuacán, El Olmo, *Biogeografía (Group) 529* (ENCB); Barranca de Monte Salas (Córdoba - Huatusco), *L. A. Pérez & F. Chiang 202* (ENCB); Jalacingo, Tecuapan, *F. Ventura 12662* (ENCB (2 sheets)); Ixhuacán, Arenal, *F. Ventura 16944* (ENCB); Huatusco, Coscontla, *F. Ventura s.n.* (ENCB (2 sheets)); Ixhuatlancillo, 10 km al O de Orizaba, *R. Torres & J. Miller 9681* (MEXU); Tepezintla, *H. Puig 4355* (ENCB); Río Blanco, along hwy. Mex. Cuota 150, Rio Blanco, between Nogales and Orizaba, *M. Nee & K. Taylor 27044* (MO); Chapingo, Jardín

Botánico del C.R.U.O., *J. D. Robledo 177* (IEB); without precise locality, *E. Bourgeau 27630* (F).

Cinnamomum erythropus (Nees et Martius) Kostermans, Reinwardtia 6: 21. 1961.

Persea erythropus Nees et Martius, Linnaea 8: 49. 1833. Type. Brazil. Minas Gerais: ad Antonio Pereira, *Martius s/n* (GZU!).

Phoebe erythropus (Nees et Martius) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 189. 1889.

Phoebe oleifolia Mez, Arbeiten Königl. Bot. Gart. Breslau 1: 117. 1892. Type. Brazil. Minas Gerais: Morro da Gloria, near Faria, 26 January 1891, *Glaziou 18434* (holotype, B, n.v.; isotypes, A!, BR!, C!, F!, G!, US!).

Cinnamomum oleifolium (Mez) Kostermans, Reinwardtia 6: 22. 1961.

Trees or small shrubs up to 2 - 6 (8) m tall; twigs smooth to conspicously ridged, one thick ridge or two narrow ones coming from petiole bases, dense to sparsely pubescent, hairs 0.2 - 0.6 mm long, spreading to erect, glabrescent when older; petiole 2 - 6 mm long, 1 - 1.5 (1.8) mm wide, densely pubescent, hairs as on twigs; leaf blade (3) 5 - 8.5 (9.5) cm long, (1) 2 - 3.5 (5) cm wide, usually obovate, often elliptic, narrowly elliptic, or oblanceolate, apex obtuse to acute, usually apiculate, base acute or acuminate, pubescent to glabrescent above, hairs spreading to erect, pubescent below, hairs rather erect, on veins and leaf surface, flakes of white wax usually present on lower surface, pinnate veined, rarely subtriplinerved, midvein impressed above, glabrous or pubescent, strongly raised below, densely pubescent, hairs more or less erect,

Figure 6. Flowering branchlet of *C. erythropus*.

secondary veins (4) 5 - 7 (10) pairs, marked above, sparsely pubescent to glabrous, raised below, pubescent, tertiary veins slightly marked or inconspicuous above, slightly raised below, domatia absent; inflorescence (7.5) 9 - 14.5 (16.5) cm long, axillary to leaves, cymose-paniculate, usually with small foliose bracts at main branchings, persistent or deciduous, peduncle 0 - 0.5 (1.5) cm long, sparsely pubescent, rachis sparsely pubescent to glabrescent, flower pedicel (2) 3 - 5 (6) mm long, glabrous; flower urceolate or narrowly campanulate, yellowish or withish, tepals 1.9 - 2.5 mm long, 1.2 - 1.8 mm wide, elliptic or ovate, glabrous outside, sericeous inside, the outer ones glabrescent toward tip and margins, some red hairs often present, stamens of whorls I & II 1.5 - 1.7 mm long, filaments sparsely sericeous ad and abaxially, sometimes only at base, anthers 0.8 - 1.1 mm long, glabrous or sparsely sericeous on connective ad and abaxially, sporangia four, stamens whorl III 1.5 - 1.8 mm long, filaments densely sericeous ad and abaxially, red hairs present adaxially, anthers 0.6 - 0.8 mm long, densely sericeous adaxially,mainly on lower half, red hairs present, glabrous abaxially, sporangia two, glands 0.3 - 0.4 mm long, at or just above filament base, glabrous except for some hairs adaxially, staminode 0.8 - 1.1 mm long, filament densely sericeous ad and abaxially, head 0.5 - 0.6 (0.8) mm long, narrowly triangular, cordate or trullate in outline, short sericeous at base adaxially, long sericeous abaxially, hypanthium 0.3 - 0.4 deep, glabrous outside, sericeous inside, sometimes sparsely so, red hairs present, pistil 1.5 - 2.2 mm long, glabrous, ovary 0.8 - 1.1 mm long, 0.6 - 0.9 mm wide; fruit 7 - 9 mm long, 4.5 - 6.5 mm wide, ellipsoid, "cupule" 2.5 - 4 mm long, 2.3 - 3.5 mm wide, with a constriction right at hypanthium and tepals' base, pedicel 2.5 - 4 mm long, 0.8 - 1.3 mm wide, tepals persistent, not enlarged.

Flowers November and January; fruits in November. Growing in ferriferous soils. Vegetation type: campo rupestre. Between 1300 - 1400 m altitude.

The decision on what material is to be selected as the type collection for this species is weak and circumstantially supported. First, Martius and Spix (1823) used the name for the first time in the book they wrote about their travels in Brazil, but gave no description or reference material for the species. Ten years later, in his paper on the Lauraceae collected by Sellow in Brazil, Nees (1833) gave the first description of the species, recognizing Martius' contribution to the name, but Sellow's collection studied is referred to without a number. In his study of the whole family, Nees (1836), who now attributes the species to Martius, cites as studied material one collection by Martius and one by Sellow, both without number. The work by Meissner (1864) for De Candolle's Prodromus cites more material, and most of it with numbers; unfortunately some of these specimens are missing and many are the bases for new created varieties. Most of authentic material known to date is that involved in the naming of varieties.

The type of indument in the lower surface and inflorescence architecture of the collection *Glaziou 18434* (type collection of *Phoebe oleifolia*) resemble the condition of those characters in *C. erythropus*. Further study in detail shows that floral characters (presence of red hairs on inner tepal surface, whorl III stamens with two sporangia) as well as fruiting characters (pedicel swollen but hypanthium flat and not enlarged), are very much alike between these two "species". Variation of size and shape of leaves, even in some duplicates of type material of *Persea erythropus*, overlaps with *P. oleifolia*, and confirms the inclusion of the latter in the former.

Specimens examined. BRASIL. **Minas Gerais**. Ouro Preto ad Cruzeiro, *Schwacke 7363*

(RB, NY); ad Antonio Pereira, *Martius s.n.* (GZU); without precise locality, *A. Glaziou 19775* (BR, C, G); Serra do Ouro Preto, *P. Claussen s. n.* (G); without precise locality, *Riedel 2777* (C, G (2 sheets)); without precise locality, *Sellow s. n.* (F); Rio Pardo, *Riedel s.n.* (NY); Ouro Preto, *Ackerman s. n.* (BR); Serra do Ouro Preto, *Martius 1238* (BR); Ouro Preto, *A. Macedo 3130* (MO); Ouro Preto, *L. Damazio s.n.* (RB (2 sheets)); without precise locality, *Riedel s.n.* (NY (2 sheets)); without precise locality, *A. Glaziou 15373* (C); Morro da Gloria, pres de Faria, *A. Glaziou 18434* (A, C, F, G, US); perto de Sabará, *L. Damazio s. n.* (RB); Serra das serrinhas, aprox. 5 km NW de Itabirito, *F. Lorea 5582* (MO).

Cinnamomum formicarium van der Werff & Lorea-Hernández, sp. nov. TYPE. Ecuador. Bolívar: Along road Chillanes - El Tambo, 1700-2300 m, 19 July 1991, (fl), *van der Werff et al. 12498* (holotype, MO; isotype, MO).

Arbores ramunculis fistulosis. Folia elliptica vel late elliptica, apice acutato, pinnatinervia, infra dense tomentella trichomatibus undulatis, adpresis, particulis ceraceis etiam abundantibus; domatiis carens. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis carens. Flos tepalis extus sicut pedicello glabris, hypanthio intus sericeo; tepalis in fructu non persistentibus.

Trees up to 20 m tall; twigs thick, fistulose, inhabited by ants, ridged, ridges comming down from petiole insertion, tomentulose, hairs 0.1 - 0.2 mm long, straight to wavy, appressed to spreading, also lepidote, both types of indument becoming sparse with age; petioles (28.5) 31.5 -

53 (77) mm long, (2.8) 3.5 - 5 (6.8) mm wide, canaliculate above, rounded below, pubescent, indument as on twigs; leaf blades (25) 28 - 40 (60) cm long, (11.5) 14.5 - 22.5 (30) cm wide, elliptic to wide elliptic, apex acute, often apiculate, base obtuse to acute, inconspicuously tomentulose to puberulent above, densely tomentulose below, hairs rather wavy, appressed, whitish particules of wax also present, surface almost concealed in some areas by the two types of indument, hairs and wax often becoming sparse with age, pinninerved, midvein slightly impressed above, more or less tomentulose to glabrous, strongly raised below, tomentulose to glabrescent, secondary veins 9 - 12 pairs, rather flat above, sparsely tomentulose or glabrous, raised below, tomentulose (particularly on the sides), or glabrescent, tertiary veins flat above, glabrous, slightly raised below, tomentulose to glabrescent, domatia absent; inflorescence (9.5) 15 - 25 cm long, axillary to leaves, cymose-paniculate, peduncle (2.5) 5.5 - 12.5 cm long, sparsely puberulent to glabrous, often fistulose, rachis rather glabrous, flower pedicel (2.2) 2.5 - 3.5 (4) mm long, glabrous; flowers narrow urceolate, greenish, tepals 3 - 4 mm long, 2.1 - 2.6 mm wide, ovate, glabrous outside, except for lower half margin area of inner tepals, sericeous inside, sometimes sparsely so on upper half in outer tepals, stamens of whorls I & II 2.2 - 3 mm long, filaments sericeous adaxially, (sparsely) tomentulose abaxially, anthers 1.2 - 1.7 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 2.3 - 3.1 mm long, filaments sericeous adaxially, sericeous abaxially, sparsely so on upper half, anthers 0.9 - 1.3 mm long, glabrous ad and abaxially, sporangia two, extrorse, although often one (or both) upper sporangia fertile but tiny, glands 0.6 - 0.8 mm long, at middle point of filament, sericeous at point of attachement adaxially, staminodes 1.5 - 2 mm long, filament densely sericeous ad and abaxially, head 1 - 1.2 mm long, cordate triangular, glabrous adaxially, sericeous abaxially at the

base, hypanthium 1.1 - 1.5 mm deep, glabrous outside, more or less sericeous inside, sometimes sparsely so, pistil 2.8 - 4.1 mm long, glabrous, ovary 1.3 - 2 mm long, 1 - 1.7 mm wide; fruit known only in young stage, ca. 10 mm long, 7.5 mm wide, ellipsoid, cupule ca. 11 mm long, 9 mm wide, basal section of pedicel thick ca. 3.5 - 4.5 mm long, 2.4 mm wide, tepals not persistent in fruit, with an oblique abscission line right at their base, falling as one piece, leaving a smooth border toward the interior of the cupule, and a sinuous border with the very base of tepals on the exterior edge of cupule's rim.

Flowers present in July; fruits (young) in August. *C. formicarium* is known so far only from a small area in central Ecuador and southeastern Colombia, in remnants of wet mountain forest, between 1700 - 2300 m along the Andean mountains.

Paratypes. COLOMBIA. **El Cauca**: Cordillera Occidental, La Gallera, Micay Valley, 1500-1800 m, (fl), *E. Killip 7904* (NY); **Valle**: Hoya del Río Cali, Río Pichindé, entre Los Cárpatos y El Olivo, 2025-2920 m, (fl), *J. Cuatrecasas 21726* (F); monte La Guarida, filo de la cordillera sobre La Carbonera, entre Las Brisas y Albán, 1950-2000 m, (fl), *J. Cuatrecasas 22176* (F). ECUADOR. **Bolívar**: along road Chillanes - Bucay, 2100 m, (fr), *V. Zak & J. Jaramillo 2564* (MO); along road Chillanes - El Tambo, 1700 - 2300 m, (fl), *van der Werff et al. 12478* (MO).

C. formicarium is a very peculiar species among neotropical *Cinnamomum*. Sizes of vegetative and floral characters are the largest recorded for any species, which in combination

with fistulose twigs inhabited by ants, pinninerved leaves, abscence of domatia, anthers of whorl III with two sporangia, and tepals not persistent in fruit, make this species a quite distinct taxon. If not for the presence of persistent indument on leaf surfaces, *C. formicarium* would be morphologically closer to the group of species with pinninerved leaves and without domatia (*C. amplexicaule*, *C. chavarrianum*, *C. chiapense*, *C. hammelianum*, *C. quadrangulum*, and *C. uninervium*). Still, similarity with *C. napoense* is stronger, for this species also has fistulose twigs (no report of ants dwelling in them has been recorded), leaves are sometimes puberulent underneath, stamens of whorl III are with two sporangia, and tepals are partially persistent in fruit. However, number of secondary veins, and indument separate clearly these two species; *C. napoense* with (5)6-7(8) pairs of secondaries, and lower leaf surface sparsely puberulous with hairs straight and appressed, without wax particles, while *C. formicarium* is with 9-12 pairs of secondaries, and lower leaf surface is densely pubescent, with hairs rather wavy, and presents wax particles.

Cinnamomum glaziovii (Mez) Kostermans, Reinwardtia 6: 21. 1961.

Phoebe glaziovii Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 216. 1889. Type. Brazil. Rio de Janeiro: Petrópolis, boundaries of Piabanha, August 1883, *Glaziou 15368*, (lectotype, B, n.v., chosen here; isolectotypes, C! (2 sheets), G!, RB! (2 sheets)).

Trees (?);twigs pubescent when young, hairs ca. 0.3 mm long, straight and rather appressed, glabrescent soon; petiole (4.5) 8 - 12.5 (14) mm long, (0.5) 1 - 1.5 mm wide,

pubescent when young; leaf blades (3.5) 7 - 12.5 (15.5) cm long, (1.5) 3 - 5 (6.5) cm wide, elliptic or obovate, apex acuminate, base acute, or short attenuate, (sparsely) pubescent when young, hairs straight, appressed, pubescent below, hairs straight, appressed, more or less persistent, triplinerved, midvein slightly sunken above, pubescent when young, strongly raised below, pubescent, secondary veins (2) 3 - 4 pairs, lower most pair marked above, strongly raised below, as thick as midvein, pubescent, upper pairs marked above, slightly raised below, tertiary veins flat above, slightly raised below, primary domatia present, usually only basal pair conspicuous, secondary domatia absent; inflorescence (4) 6.5 - 12.5 (13.5) cm long, axillary to leaves, or to foliose deciduous bracts (?), cymose-paniculate, pauciflorous, foliose bracts sometimes present at main branchings, peduncle (2) 3.5 - 6.5 (7.5) cm long, sparsely pubescent, rachis sparsely pubescent to glabrescent, flower pedicel (3.5) 4.5 - 6.5 (8) mm long, glabrous; flowers narrow campanulate, tepals 2.1 - 2.8 mm long, 1.4 - 1.9 mm wide, ovate, glabrous or sparse and minutely pubescent outside, short sericeous inside, outer ones sometimes glabrous toward their margins, stamens of whorls I & II 1.9 - 2.1 mm long, filaments sericeous along median section adaxially, glabrescent abaxially, anthers ca. 1 mm long, glabrous ad and adaxially, sporangia four, stamens of whorl III 2 - 2.3 mm long, filaments sericeous adaxially, glabrescent abaxially, anthers ca. 0.9 mm long, sparsely sericeous at base adaxially, glabrous abaxially, sporangia four, sometimes upper ones fused with lower ones, looking like three or two sporangia, glands 0.5 - 0.7 mm long, above filament base, in between the first third of its lenght, sericeous adaxially, staminodes 1.1 - 1.4 mm long, filament sericeous ad and abaxially, head 0.7 - 1 mm long, cordate acuminate in outline, glabrous adaxially, sericeous at base in the middle abaxially, hypanthium 0.8 - 1.1 mm deep, glabrous or sparse and minutely pubescent outside,

dense sericeous inside, pistil 2.8 - 3.3 mm long, glabrous, ovary 1.1 - 1.3 mm long, ca. 1 mm wide; fruit not known, tepals not persistent, falling as one piece after anthesis.

Flowers in August. No fruits have been collected; the fruits of the collection *Binot 22* are diseased. *C. glaziovii* is known from very few collections, all around the same locality as lectotype, a small area north of Rio de Janeiro.

This species is distinguished by having leaves with scattered straight appressed hairs on lower surface, and tepals not persistent in fruit, from its closest morphologically related species, *C. pseudoglaziovii*, which has wavy to curly hairs on lower leaf surface, and tepals partially persistent in fruit (see additional comments under that species).

From the four collections mentioned by Mez in the original description (*Glaziou 6668*, *8097*, *15368*; *Binot 22*) I chose *Glaziou 15368* as the lectotype for it has good mature open flowers and matches closely Mez's diagnosis for the species. Furthermore, that collection is well represented in several herbaria.

Specimens examined. BRASIL. **Rio de Janeiro**. margen do Piabanha, *A. Glaziou 15368* (RB, C (2 sheets), G); Alto Macana, *A. Glaziou 18439* (F, NY, BR, G); without precise locality, *A. Glaziou 6668* (BR), C (2 sheets), G); without precise locality, *A. Glaziou 8097* (NY, C (2 sheets), G, BR); without precise locality, *Binot 22* (BR (4 sheets)).

Cinnamomum glossophyllum Lorea-Hernández, sp. nov. TYPE: Mexico. Nayarit: Mpo. Nayar, 12 km N of Linda Vista on the road to Santa Teresa, 2250 m, 3 August 1990, (fl), *G.*

Flores 2198 (holotype, MEXU; isotypes, FCME, MO).

Arbores parvae. Folia longa anguste elliptica aut lanceolata, apice acuminato vel obtusato, subtriplinervia aut triplinervia, infra villosa-tomentosa trichomatibus undulatis vel crispis, patulis; domatiis praesentibus ad axillas nonnullas venarum secundariarum et tertiariarum, pagina foliari utrinque ad domatia subplana. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis carens. Flos tepalis extus sicut pedicello dense tomentosis, hypanthiuo intus pubescente; tepalis integris (?) in fructu persistentibus.

Small trees ?; twigs dense villous-tomentose, stem surface hardly seen through hairs, hairs 0.6 - 0.8 (1.2) mm, some wavy and more or less appressed, matted, others rather erect, more or less straight, persistent; petiole (11) 15 - 20 (23) mm long, 1.2 - 1.6 mm wide, dense villous-tomentose, hairs as on stems; leaf blades (6) 13.5 - 23 cm long, (2.5) 3.5 - 5 (6) cm wide, narrow elliptic to lanceolate, apex acuminate or (usually) blunt obtuse by arrest of apical meristem, base cuneate, villous-tomentose above and below, surfaces not concealed, hairs wavy to curly, long persistent, but finally glabrous above, subtriplinerved to triplinerved, midvein (rather) flat above, densely villous-tomentose, strongly raised below, dense villous-tomentose, hairs long persistent, secondary veins 5 - 7 pairs, flat above, raised below, dense villous-tomentose above and below, finally glabrous above, tertiary veins flat above, slightly raised below, primary domatia present at axils of several secondaries, sometimes inconspicuous, secondary domatia usually present at base of several tertiaries bases; inflorescences 4 - 11 cm long, axillary to leaves, cymose-paniculate, peduncle 2.5 - 7 cm long, villous-tomentose, rachis villous-tomentose, flower pedicels 2.5 - 3.5

mm long, dense tomentose; flower urceolate, tepals 2.4 - 2.8 mm long, 1.8 - 2.2 mm wide, ovate or wide ovate, dense tomentose outside, dense sericeous inside, stamens of whorls I & II ca. 1.5 mm long, filaments glabrous adaxially, glabrous abaxially or sparsely sericeous, anthers ca. 1 mm long, glabrous ad and abaxially, sporangia four, in two pairs, introrse, stamens of whorl III ca. 1.5 mm long, filaments apparently glabrous ad and abaxially, anthers ca. 0.9 mm long, glabrous ad and abaxially, sporangia four, in two pairs, upper ones latrorse, lower ones latrorse-extrorse, glands 0.5 mm long, at filament base, ovate, sparsely sericeous at point of attachment adaxially, glabrous abaxially, staminodes 0.8 - 0.9 mm long, pedicel glabrous adaxially, sparsely sericeous abaxially, head 0.6 mm long, ovate acuminate in outline, glabrous ad and abaxially, hypanthium 0.4 - 0.3 mm deep, densely tomentose outside, (sparsely) sericeous inside, some red hairs present, glabrous outside and inside, pistil glabrous; ripe fruit not known.

The single collection known for this species has old flowers and very young fruits. Thus, it seems that flowers should be present by June-July, and fruits should mature by the end of the year. Pine-oak forest is the habitat where this species grows, at an altitude of 2250 m.

In general, vegetative morphological characters of *C. glossophyllum* are reminiscent in a way of some specimens of *C. hartmanii*. But leaves in *C. glossophyllum* are densely covered on upper and lower surfaces by rather persistent wavy to curly hairs, and tepals in young fruits do not show any sign of having an abscission line, indicating that they are persistent. Besides, tepals are conspicuously pubescent on their external surface in *C. glossophyllum*, but glabrous in *C. hartmanii*. Thus, although only one collection was at hand, there is no doubt that it represents a distinct entity. Leaves in the new species resemble tongues, therefore the name.

Figure 8. Known distribution of (★) *C. glaziovii*, (■) *C. glossophyllum*, (●) *C. grisebachii*, (▲) *C. hammelianum*, and (○) *C. hartmanii*.

Cinnamomum grisebachii Lorea-Hernández, nom. nov.

Phoebe triplinervis Grisebach, Mem. Amer. Acad. Arts n.s. 8: 187. 1861. Type. Cuba. Oriente: Monte Verde, near Guantánamo, *Wright 1400* (holotype, GOET n.v.; isotypes, BR!, G!, GH!, P!). non *Phoebe triplinervis* (Ruiz & Pavón) Mez. The name *Cinnamomum triplinerve* (Ruiz & Pavón) Kostermans prevents the use of the original epithet for the species.

Phoebe antillana var. *cubensis* Meissner, in DC. Prodr. 15: 31. 1864. (pro parte).

Phoebe grisebachiana Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 215. 1889. Basionym *Phoebe triplinervis* Grisebach. Illegitimate name.

Trees 7 - 8 (17) m tall; twigs pubescent when young, glabrescent or glabrous soon, hairs ca. 0.2 mm, straight, appressed or slightly spreading; petioles (8.5) 12.5 - 21 (30) mm long, (0.8) 1.1 - 1.6 (2) mm wide, sparsely pubescent, soon glabrous, hairs as on twigs; leaf blades (5) 9 -16 (23) cm long, (1.5) 3 - 6 (9) cm wide, narrowly elliptic or elliptic, apex acute to short acuminate, base acute, glabrous above and below, triplinerved or subtriplinerved, midvein marked to flat above, glabrous, strongly raised below, glabrous or glabrescent, secondary veins 4 - 5 (6) pairs, lowest pair much more conspicuous than the others, ascending, flat above, raised below, glabrous, upper pairs flat above, slghtly raised below, tertiary veins flat above, rather flat below, primary domatia present, only the lowest pair, secondary domatia absent; inflorescence (2) 3 - 6 (7.5) cm long, axillary to leaves, simple, or axillary to small deciduous bracts and borne by short axillary branches, paniculate, last branchings usually contracted, peduncle absent or up to 2.5 (3.5) cm long, pubescent, rachis pubescent, flower pedicel 2 - 4.5 mm long, glabrous; flowers

urceolate, greenish, tepals 2.3 - 3 mm long, 1.6 - 2.2 mm wide, ovate to widely ovate, glabrous outside, outer ones glabrescent inside, inner ones sericeous inside, stamens of whorls I & II 1.7 - 2.3 mm long, glabrous ad and abaxially, sometimes sparsely pubescent at base ad and abaxially, anthers 1 - 1.3 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 1.7 - 2.3 mm long, glabrous ad and abaxially, anthers 0.8 - 1 mm long, glabrous ad and abaxially, sporangia four, upper ones latrorse, lower ones extrorse-latrorse, glands 0.5 - 0.7 mm long, above filament base, ovate, glabrous ad and abaxially, sometimes sparsely sericeous adaxially at point of attachment, staminodes 0.9 - 1.2 mm long, filament glabrous ad and abaxially, or sparsely sericeous abaxially, head ca. 0.6 mm long, ovate-triangular in outline, glabrous ad and abaxially, hypanthium 0.5 - 0.7 (0.8) mm deep, glabrous outside, glabrous inside, pistil 2 - 2.2 mm long, glabrous, ovary 1 - 1.2 mm long, 0.9 - 1.1 mm wide; fruit 13.5 - 17.5 mm long, 9.5 - 11.5 mm wide, cupule 8.5 - 13.5 mm long, 7 - 9 mm wide, narrowing to a bottom 1.7 - 2.5 mm wide, pedicel not distinct, tepals persistent.

Flowering season for this species is from March through August; fruits are present in December, January, and April. The type of vegetation where this species grows is pine forest, but it can be found also in secondary forest, between an altitude of 950 - 1500 (2000) m in Cuba and Dominican Republic. In Mexico, it is found at lower altitudes, between 20 (?) - 100 m.

As considered here, *C. grisebachii* differs from *C. costaricanum*, its closest morphological relative, by having fruit pedicels narrow turbinate from top to bottom, branchings of inflorescence with terminal dichasia sessile, frequently reduced in number of flowers, looking glomerulate, and domatia trichomes mostly parallel to leaf surface; as opposed to fruit pedicels

turbinate distally, terminal dichasia of inflorescence distinct, and domatia trichomes rather spreading to erect in *C. costaricanum*. Certainly the differences are not strong, but given the correlation of characters with geographic distribution I prefer for the moment to keep them as two different species.

In the original description, two collections (*Wright 482, 1400*) are referred to, yet, *Wright 482* was added to Grisebach's manuscript by A. Gray (Gray in Grisebach, 1861: 151); thus there is no need for lectotypification. Under the synonyms of *Phoebe grisebachiana* Mez also listed *P. cinnamomifolia* A. Richard, and *P. parviflora* Nees, however the former name was not published, and the later could not be attached to any particular specimen.

Specimens examined. CUBA. **Pinar del Río**. Sierra de los Organos, Grupo del Rosario, valley of Río Santa Cruz., *E. L. Ekman 16389* (NY, G); Sierra Organos, on the road between Ballestena and Ranzel, in forest at Río Taco-Taco, *E. L. Ekman 13782* (NY, G). **Oriente**. Monte Verde, near Guantánamo, *C. Wright 1400* (BR, P, G, GH); without precise locality, *C. Wright 482* (G, NY(2 sheets), BR); La Prenda, *Bro. Hioram & Chas. Maurel 6053* (NY); without precise locality, *R. de la Sagra s.n.* (P); Buenos Aires, Trinidad Hills, *J. G. Jack 8601* (NY). DOMINICAN REPUBLIC. **La Vega**. Near La Culata, 10 km W of Constanza, then 3 km by foot up canyon, *R. Carter & R. Garcia 5228* (MO (5 dups)); Cordillera Central, La Vega, Constanza, en el lugar llamado La Culata, en la loma El Campanario, *R. Garcia & R. Carter 1829* (NY); La Vega, 5 km S of Constanza, on road to El Convento, *M. Mejia & T. Zanoni 7670* (NY); La Vega, 6 km SE of La Culata de Constanza on road to Constanza, *M. Mejia & T. Zanoni 12323* (NY); Bosque en ladera, barranca del Río Grande, Constanza, *A. Liogier 21079* (NY). MEXICO.

Oaxaca. Uxpanapa region, along gravel road from Esmeralda (17 km E of Sarabia) to Río Verde, 1.1 mile S of Esmeralda, *T. Croat & D.P. Hannon 63214* (MO(2 dups)); Tuxtepec, Chiltepec and vicinity, *G. Martínez-Calderón 119* (MEXU); Tuxtepec, Chiltepec, *G. Martínez C. 173* (MEXU); Matías Romero, Uxpanapa region, aprox. 22 km al S de Esmeralda, aprox. 9 km al S de Aserradero La Floresta, lomas al S de Río Verde, *T. Wendt et al. 3054* (MO); Tuxtepec, *C. Ramos 616* (FCME (4 dups)). **Tabasco**. Without precise locality, *A. Hanan 345* (FCME).

Cinnamomum hammelianum (W. Burger) Lorea-Hernández, comb. nov.

Phoebe hammeliana W. Burger, Fieldiana, Bot. n.s. 23: 113. 1990. Type. Costa Rica. San José: 0.9 km above La Chonta. *R. W. Lent 1678* (holotype, CR n.v.; isotypes, F!, NY!).

Trees 8 - 20 m tall; twigs densely or sparsely tomentulose near the terminal shoot bud, hairs 0.1 - 0.2 mm long, straight, appressed, becoming scarse very soon with age; petioles (6) 12 - 22 (28) mm long, (1) 1.5 - 2.3 (2.8) mm wide, glabrescent, hairs as on twigs; leaf blades (5) 9 - 20 (29) cm long, (2.5) 3.5 - 8.5 (15) cm wide, elliptic or ovate, apex acute to acuminate, base round or obtuse (rarely subcordate), glabrous above and below, sparsely pubescent below when young, pinninerved, midvein strongly impressed or sunken above, glabrous, raised below, glabrous, secondary veins (5) 7 - 9 (10) pairs, slightly impressed or flat above, glabrous, slightly raised below, glabrous, tertiary veins flat above, almost flat below, domatia absent; inflorescences (6) 8.5 - 17 (20) cm long, usually clustered on short branches axillary to leaves, or single, or clustered close to terminal shoot buds, cymose-paniculate, foliose bracts sometimes

present, peduncle (0.3) 2 - 7 (8.5) cm long, puberulous, rachis puberulous to glabrescent, flower pedicel (3) 3.5 - 4.5 (5) mm long, glabrous; flowers , tepals 2.1 - 3.2 mm long, 1.9 - 2.4 mm wide, ovate or wide ovate, glabrous outside (inner ones with few hairs in lower altitude specimens), sericeous inside, sparsely so the outer ones (not so in low altitude specimens), stamens of whorls I & II 1.5 - 2.2 mm long, filaments sparsely sericeous adaxially along median section, glabrous abaxially (sericeo-villose ad and abaxially in low wltitude specimens), anthers 0.9 - 1.5 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 1.5 - 2.2 mm long, sparsely sericeo-villose adaxially, glabrous abaxially (sericeo-villose ad and abaxially in low altitude specimens), anthers 0.7 - 1 mm long, glabrous ad and abaxially, sporangia four, upper ones latrorse, lower ones latrorse-extrorse, glands (0.5) 0.7 - 0.8 mm long, at filament base, glabrous or sparsely sericeous adaxially at point of attachement, staminodes 0.8 - 1.5 mm long, filament sparse to densely sericeo-villose adaxially, glabrous abaxially or glabrescent (sericeo-villose ad and abaxially in low altitude specimens), head 0.5 -1.1 mm long, triangular cordate, glabrous ad and abaxially (sparsely sericeo-villose at base abaxially in low altitude specimens), hypanthium 0.5 mm deep, glabrous outside, glabrous inside, pistil 1.6 - 2.6 mm long, ovary 0.9 - 1.1 mm long, 0.8 - 1 mm wide; fruit 18 - 20.5 mm long, 9 - 12.5 mm wide, ellipsoid, cupule 9.5 - 11.5 mm long, 6.5 - 8 mm wide, narrowing to a base 3.5 - 4.5 mm wide, pedicel indistinct, tepals partially persistent.

Flowers are present from May to July; ripe fruits can be found in March and June. Habitat of this species includes primary forest and secondary vegetation, between 650 and 2500 m. The area of distribution goes from western and southern Costa Rica and western Panama along

mountain ranges.

As Burger mentioned in the original publication, *C. hammelianum* is morphologically similar to *C. chavarrianum*, and the only vegetative character that helps to distinguish that species from the latter one is the appearance of the lower leaf surface; light green and smooth in *C. hammelianum*, glaucous and papillose in *C. chavarrianum*. The best character is the persistence of tepals in the fruit; partially deciduous in the former, entire persistent in the latter. Unfortunately, contrary to what is found in other species, tepals in *C. hammelianum* fall off long after anthesis, making flowering material hard to separate.

Type material of *C. hammeliana* (which is with flower buds only), for some reason mostly has anthers with aborted sporangia, looking rather like an *Ocotea* species. Fruiting material cited as paratypes seems to be conspecific with the type, but flowering material referred as paratype (from lower altitude) does not look similar to the type. However, there are no fruiting collections from the same lower altitude areas that could help to solve this problem. Thus, all the specimens that look similar to the material cited in the original publication is considered here under one name, although there might be two taxa involved.

Specimens examined. COSTA RICA. **Alajuela**. Naranjo, Zona Protectora Chayote, Llevo Bonito, *L. D. Gomez et al. 23977* (MO); Upala, Cordillera de Guanacaste, Bijagua, *D. Penneys 414* (MO (7 dups)); Reserva Forestal de San Ramón, por sendero que sube a la fila hacia el SO de la estación., *G. Herrera 534* (MO); Along the Sarapiquí rd., about 1.5 km N of Finca Isla Bonita, *G. Hartshorn 1456* (MO); San José to Vara Blanca on route 9 km 20, B. *Hammel & M. Grayum 14091* (MO); **Guanacaste**. Parque Nacional Guanacaste, Est. Pitilla y Sendero El

Mismo, *P. Rios 366* (MO); Parque Nacional Guanacaste, Est. Pitilla, Fila Orosilito, *B. Hammel et al. 17406* (MO); Parque Nacional Guanacaste, Est. Pitilla, sobre fila al cerro Orosilito, *R. Robles et al. 2797* (MO); Parque Nacional Guanacaste, Est. Pitilla, Fila Orosolito, *B. Hammel et al. 17405* (MO).Costa Rica. **Heredia**. South slope of Volcán Barba, along road above Porrosati, *G. Hartshorn 1125* (MO). **Puntarenas**. Res. Vida Silvestre Golfito, cerro Las Torres, Fila divisoria con Río Machaca, Golfito, *G. Herrera 5038* (MO); Cantón de Osa, Rancho Quemado, Sector Norte, camino a Cerro Chocuaco, *J. Marin 424* (MO); R.N.V.S., Golfito, camino a las torres del ICE, cabecera del Río Sorpresa, 5 km al este, *N. Zamora et al. 1929* (MO). **San José**. About 100 m to the right off the Pan American Hwy., 0.9 km above La Chonta, *R. W. Lent 1678* (NY, F); Cerros de Escazú, Cedral, Falda NO del Alto Hierba Buena, cuenca del Río Suárez (Cucubres), *J. F. Morales 219* (MO); Cantón de Aserri, Cerros de Escazú, La Carpintera. Alto Hierbabuena. Cerro Daser, *J. F. Morales & R. J. Abarca 3714* (MO); San Isidro del General 2.5 km O de la ciudad, entre Hoyón y Pedregoso, *B. Hammel 17298* (MO); El Empalme, finca de Don Isaías Solano Jiménez (Don Chayo), *L. Poveda et al. 4187* (MO). PANAMA. **Chiriquí**. Boquete, Finca Lerido, *L. Quiroz & E. Garrido 268* (MO).

Cinnamomum hartmanii (I. M. Johnston) Kostermans, Reinwardtia 10: 444. 1988.

Persea hartmanii I. M. Johnston, Contr. Gray Herb., n.s. 70: 69. 1924. Type. Mexico. Chihuahua: Batopilas, Batopilas, April 1892, *Hartman 1029* (holotype, GH, n.v.; isotype, MO!).

Trees 6 - 10 (15) m, or shrubs (?) 2 m tall; twigs slightly ridged to smooth, villous-tomentose, hairs 0.3 - 0.6 mm long, spreading to erect, more or less straight to wavy, glabrescent with age; petioles (8) 9.5 - 16 (21) mm long, (0.7) 1 - 1.2 (1.4) mm wide, villous-tomentose, glabrescent with age, hairs as on twigs; leaf blades (4) 8 - 15 (20) cm long, (1.5) 2.5 - 5 (7) cm wide, narrow elliptic to elliptic, apex acute, base acute, leaf surface tomentose above when young, soon glabrous, villous-tomentose to glabrescent below, pinninerved, subtriplinerved, or triplinerved, midvein tomentose above when young, soon glabrous, rather flat, raised below, sparsely tomentose to glabrescent, secondary veins 5 - 7 (8) pairs, flat above, glabrous, slightly raised below, glabrescent, tertiary veins flat above, glabrous, slightly raised below, glabrous, primary domatia absent or present, one to several pairs, secondary domatia absent; inflorescence (4) 7.5 - 18 (24) cm long, axillary to leaves or to deciduous foliose bracts, cymose paniculate, peduncle (2) 3.5 - 8 (10.5) cm long, sparsely tomentose to glabrescent, rachis sparsely tomentose to glabrous, flower pedicel (2) 3 - 6 (9.5) mm long, glabrous; flowers narrowly urceolate, tepals 2.1 - 2.8 mm long, 1.3 - 2.1 mm wide, ovate or widely ovate, glabrous outside, or inner ones sparsely pubescent, or all sparsely pubescent, sericeous inside, rarely some red hairs present, stamens of whorls I & II 1.5 - 2 mm long, filaments glabrous ad and abaxially, or sparsely sericeous abaxially, anthers 0.8 - 1.1 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 1.5 - 2.1 mm long, filaments sericeous adaxially, glabrous abaxially or sparsely sericeous, anthers 0.7 - 1 mm long, glabrous ad and abaxially, or sericeous on lower half adaxially, sporangia four, upper ones latrorse, lower ones extrorse-latrorse, glands 0.5 mm long, at filament base, sparsely long sericeous adaxially at point of attachment, glabrous elsewhere, staminodes 0.9 - 1.2 mm long, filament long sericeous adaxially and along the

margins, glabrous or sparsely long sericeous abaxially, head 0.6 - 0.8 mm long, wide triangular in outline, acuminate, glabrous ad and abaxially, or sparsely sericeous at base abaxially, hypanthium (0.3) 0.4 - 0.6 mm deep, glabrous outside or sparsely pubescent, sericeous inside, sometimes sparsely so, red hairs sometimes present, pistil 1.9 - 2.3 mm long, glabrous, ovary 1 - 1.2 mm long, 0.9 - 1.1 mm wide; fruit 9.5 - 13.5 mm long, 6 - 8.5 mm wide, ellipsoid, cupule 4 - 8.2 mm long, 2 - 5.4 mm wide, tepals partially persistent, with an abscission line close to the middle, pedicel 1.5 - 2.8 mm long, 0.6 - 1.4 mm wide, distally swollen, turbinate.

Most collections suggest this species flowers in early spring (March, April), but rarely also flowers in January. Mature fruits are found in May and July. The habitat where this species grows is in the contact zone of oak forests with semideciduous tropical forest or even in deciduous tropical forest, between (330) 500 - 1100 m altitude. Its geographical distribution extends on a wide area in the nortwestern Sierra Madre in Mexico, including the states of Chihuahua, Sonora, Durango, Nayarit and Jalisco.

Vegetative morphology, particularly of leaves, is very variable in this species. However, the consistent features of tepals with an abscission line at or above their base, and persistent bases of tepals that tend to be erect and forming like a cup at the fruit base, make it a clear cut entity.

Specimens examined. MEXICO. **Chihuahua**. Sierra Madre Occidental between Creek and La Bufa, canyon of Batopilas, on canyon floor near mouth of creek called Arroyo San Fernando, *V. Siplivinsky et al. 4006* (NY); Ocampo River, *H. LeSueur 1246* (F, MO); Temoris

Station on Chihuahua al Pacífico RR, *I. W. Knobloch 2094* (ENCB); Batopilas, Arroyo La Bufa, E of La Bufa in short tree and oak forest on N side of Barranca de Batopilas, *R. A. Bye 8588* (NY); Batopilas, *C. V. Hartman 1029* (MO). **Durango**. Tepehuanes, Quebrada Honda, *A. Benítez P. 557* (MEXU). **Jalisco**. Cuautitlán, 1-2 km al W del Durazno, *R. Cuevas & M. Rosales 1877* (IEB); Cuautitlán, 13 km al NE de Cuautitlán, *F. J. Santana & L. Guzman 3352* (MO); Ruíz, después de El Zopilote rumbo a Santa Cruz del Guaybel, *M. Cházaro B. et al. 5471* (IEB); Talpa de Allende, camino a la mina del Cuale, 18.5 km al E de la carretera Puerto Vallarta-Barra de Navidad, *E. J. Lott 2537* (MO); Tecalitlán, 34 km, al S de Cd. Guzmán por carr. a Pihuamo, *V. Pichardo 298* (MO); Tuxpan, al NE de La Higuera, *B. Zembrano s.n.* (IEB); Brecha de Cusalapa, *A. Ramos Q. & J. A. P. de La Rosa 1* (MEXU, ENCB); 4 km al N de Pihuamo, *J. Rzedowski 15282* (ENCB, MEXU). **Nayarit**. Along Hwy 200 between Tepic and Puerto Vallarta, 33 miles S of Tepic, 4 miles N of Las Varas, *T. Croat 45362* (MO); Xalisco, 0.5 km al E de El Tepozal, camino Xalisco-Las Meras; aprox. 20km al SW de Tepic, *F. Lorea 5509* (FCME (13 dups)); Compostela, aprox. 10 km al E de Compostela, sobre la carretera Compostela-San Pedro Lagunillas, *F. Lorea et al. 5512* (FCME (15 dups)); 20 km al NW de Tepic, sobre la carretera a Acaponeta., *J. Rzedowski 15590* (ENCB); Tepic, El Ahuacate, *R. Ruenes 875* (FCME (2 sheets)); Santa Maria del Oro, 3 km NW of El Ocotillo, near the Hwy to Tepic, along a small permanent stream, *R. McVaugh 23518* (ENCB); Along dirt road to Cuarenteno, 2-10 km from El Izote on Hwy. between Tepic and Miramar, *J. S. Miller & O. Téllez 3150* (MO); San Blas, Cráter del Volcán La Cebadilla al S de Mecatan, *R. González & M. Blanco 1186* (FCME); Along the dirt road to Cuarenteño, 2-10 km from El Izote on hwy between Tepic and Miramar, *J. S. Miller & O. Tellez 3147* (MO, C); Along the dirt road between Pochititan and Francisco Madero, *J. S.*

Miller & O. Téllez 3182 (MO); San Blas, Barranca en la ladera SW del Volcan La Yerba, *R. González & M. Blanco 920* (FCME); 2 miles east of junction of Hwy. 15 and road to Santa Maria del Oro, which is 22 miles east of Tepic, *L.J. Bussjaeger s.n.* (F). **Sonora**. Arroyo Tepopa, below old ranch site, *M. Fishbein et al. 953* (MO); Arroyo Gochico, about 6.5 km east of San Bernardo, *M. Fishbein et al. 2148* (MO); Arroyo Gochico, below Gochico Viejo, about 11 km east of San Bernardo., *M. Fishbein et al. 2153* (MO); Vinata, Rio Mayo, *H.S. Gentry 1478* (F, MEXU, MO); Arroyo Gochico, Río Mayo, *H.S. Gentry 3630* (MO, F); Arroyo Gochico, Río Mayo, *H.S. Gentry 3629* (MO, F).

Cinnamomum hatschbachii Vattimo, Arch. Jard. Bot. Rio de Janeiro 17: 222. 1962. Type. Brazil. Paraná: Guaratuba, Serra de Araçatuba, 31 January 1960, *Hatschbach 6682* (holotype, RB!; isotypes, HB!, US!).

Trees (?) or shrubs 2 - 3 m tall; twigs pubescent, hairs 0.2 - 0.4 (0.7) mm long, straight and appressed or less, subappressed, glabrescent or glabrous when older; petiole (2.5) 4.5 - 9.5 (12.5) mm long, 0.5 - 1 (1.3) mm wide, pubescent, hairs like on twigs, glabrous when older; leaf blade (1.5) 3 - 4.5 (5.5) cm long, (1) 1.5 - 2 (3) cm wide, elliptic or obovate, apex acute to acuminate, base cuneate, glabrous above and below, sparsely pubescent on both sides when young, hairs straight and appressed, triplinerved or few subtriplinerved, midvein slightly sunken above, glabrous, raised below, glabrous or glabrescent, secondary veins (1) 2 (3) pairs, marked above, glabrous, lowest pair raised below, other pairs less conspicuos, tertiary veins marked above, slightly raised below, primary domatia present, usually only the lowest pair, sunken

below, conspicuosly ampullaceous above, if other pair of primary domatia present, these slightly sunken and not ampullaceous, secondary domatia absent; inflorescence (1.3) 1.7 - 3 cm long, axillary to leaves, cymose, usually just one or two divisions, rather congested and looking umbelliform, peduncle (0.7) 1 - 2.2 cm long, sparsely pubescent, rachis sparsely pubescent, flower pedicel (1.5) 2 - 4.5 (6) mm long, glabrous or glabrescent; flower cream or greenish, tepals 1.8 - 1.9 mm long, 1.1 - 1.6 mm wide, ovate, outer ones glabrous outside, inner ones glabrous or usually sparsely pubescent, both sericeous inside, stamens of whorls I & II 1.1 - 1.4 mm long, filament glabrescent or glabrous adaxially, short sericeous abaxially, anthers 0.7 - 0.9 mm long, sparsely short sericeous on connective abaxially, elsewhere glabrous, sporangia four, stamens of whorl III 1.3 - 1.5 mm long, filament sparsely sericeous adaxially, same along median section abaxially, anthers 0.7 - 0.9 mm long, sparsely pubescent on basal margin adaxially, otherwise glabrous, sporangia four, glands ca. 0.4 mm long, at filament base, sparsely sericeous at base adaxially, staminode 0.7 - 1 mm long, filament glabrous adaxially, sericeous abaxially, head 0.5 - 0.7 mm long, triangular or cordate in outline, glabrous adaxially, sericeous along median section abaxially, hypanthium 0.3 - 0.4 mm deep, glabrous or glabrescent outside, glabrous inside, pistil 1.5 - 1.9 mm long, glabrous, ovary ca. 1 mm long, ca. 1 mm wide; no mature fruits known, tepals falling off as one piece early in fruit developement.

Flowers in December to January. Vegetation type: matinha nebular, capão do campo. Between 850 and 1400 m altitude. Geographic distribution of this species is restricted to a very small area on the border of Paraná and Santa Catarina states in Brazil.

Vattimo (1962) considered size of the leaves in this species as a character that helps to

Figure 9. Flowering branchlet of *C. hatschbachii*.

distinguish it from other species (at least locally), but this feature is not as good as the combination of sunken primary domatia, glabrous hypanthium inside, and tepals falling off as a unit early in fruit development. This species is included in *Cinnamomum* despite the lack of persistent tepals, for its floral and leaf morphology strongly suggest the affinity with the rest of species studied here, as commented for *C. alainii* too.

Specimens examined. BRASIL. **Paraná**: Guaratuba, Serra de Araçatuba, *G. Hatschbach 6682* (RB (2 sheets), NY, US); Guaratuba, Morro do Araçatuba, *R. Kummrow et al. 3354* (MBM). **Santa Catarina**. Monte Crista, São Francisco do Sul, *Reitz & Klein 10643* (RB); Monte Crista, Garuva, São Francisco do Sul, *Reitz & Klein 5894* (RB).

Cinnamomum haussknechtii (Mez) Kostermans, Reinwardtia 6: 21.1961.

Phoebe haussknechtii Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 186. 1889. Type. Brazil. Without precise locality, *Sellow 1082* (holotype, B, n.v.; phototype, G!).

Shrubs or small trees 0.7 - 2 (4) m tall; twigs dense to sparsely pubescent, hairs spreading to erect, 0.4 - 0.6 (0.8) mm long, slightly wavy to straight, rather persistent, sometimes stripes of red hairs present; petioles (1) 2 - 3.5 (4.5) mm long, (0.5) 1 - 1.6 mm wide, densely pubescent, hairs as on twigs; leaf blades (2) 4 - 6.5 (8) cm long, (1) 2 - 3.5 (4.5) cm wide, ovate or elliptic, apex acute or obtuse, often apiculate, base obtuse to widely rounded, tomentose above when young, glabrous with age, hairs appressed to spreading, dense to sparsely pubescent below, hairs

spreading to erect, undersurface usually glaucous, triplinerved or trinerved, occasionally subtriplinerved, midvein marked above, tomentose when young, glabrescent with age, raised below, pubescent, secondary veins (3) 4 (5) pairs, lowest pair marked above, raised below, pubescent, other pairs slightly marked above, raised below, pubescent, tertiary veins inconspicuous above, slightly raised below, pubescent, primary domatia absent,or sometimes only the lowest pair present (?), secondary domatia absent; inflorescences (4.5) 7 - 11 (12.5) cm long, axillary to leaves or to small foliose bracts at the base of new branches, cymose-paniculate, peduncle (2.5) 3.5 - 6 (7.5) cm long, sparsely pubescent, rachis sparsely pubescent to glabrescent, flower pedicel (2.5) 3 - 5 (6) mm long, glabrous; flowers urceolate, pale yellowish white or pale greenish yellow, tepals 2 - 2.6 mm long, 1.6 - 2.2 mm wide, ovate to widely ovate, glabrous outside, sericeous inside, red hairs present, stamens of whorls I & II 1.5 - 2 mm long, filaments sparsely sericeous on median section adaxilly, glabrous or glabrescent abaxially, anthers 1 - 1.4 mm long, glabrous ad and abaxially, or sparsely retrorse pubescent on the base of lower sporangia, sporangia four, introrse, stamens of whorl III 1.5 - 2.1 mm long, filaments pubescent adaxially, red hairs rather abundant, sparsely sericeous on median section abaxially, anthers 0.7 - 1.1 mm long, sericeous adaxially, particularly on lower half and median section, red hairs abundant, glabrous abaxially, sporangia two, extrorse, sometimes four and the upper ones very small and latrorse, glands 0.5 - 0.6 mm long, just above filament base, ovate to oblate, sericeous adaxially on median section, staminodes 1.1 - 1.4 mm long, filament sericeous adaxially, glabrescent or sericeous on median section abaxially, head 0.6 - 0.9 mm long, deltate-cordate to narrowly deltate, glabrous adaxially, sparsely sericeous on median section at base abaxially, hypanthium 0.4 - 0.6 mm deep, glabrous outside, sericeous inside, red hairs present, pistil 2 - 2.4

mm long, glabrous, ovary 0.9 - 1.1 mm long, 0.9 - 1.1 mm wide; fruit 8.5 - 10.5 mm long, 6 - 8.5 mm wide, ellipsoid, cupule 3.5 -6 mm long, 4 - 5 mm wide, pedicel 1 - 3 mm long, 0.8 - 1.2 mm wide, or absent, tepals partially persistent, sometimes distal half remaining but withered, finally falling off.

Flowers present in January, March, and September; ripe fruits in October, November, and March. This species seems to be a common one in the cerrado vegetation of the highlands in south-central Brazil (Goiás, Minas Gerais), between 850 - 1200 m altitude.

As indicated above, no authentic material for the species could be seen and studied. However, most of the specimens here considered under this name fit well the original description, and several ones match the general appearance of the type (as seen in the photograph). Therefore, instead of creating a new name, I preferred to apply the combination *Cinnamomum haussknechtii* to these specimens hoping the type material can be studied later to confirm this decision.

The characters that help to separate this species from others in the area is the combination of leaves with lower surface more or less pubescent (hairs not appressed), usually glaucous, anthers of whorl III with two sporangia (or if four, the upper ones conspicuously reduced), and tepals partially persistent. Leaf shape and pubescence vary widely, but the characters mentioned above are good enough to hold all these specimens together. *Harley et al. 25777* is a case of extreme variation; its deep red hairs on the veins would key it out to *C. rubrinervium*, but hairs do not conceal leaf surface, which is glaucous, and therefore it is placed in *C. haussknechtii*.

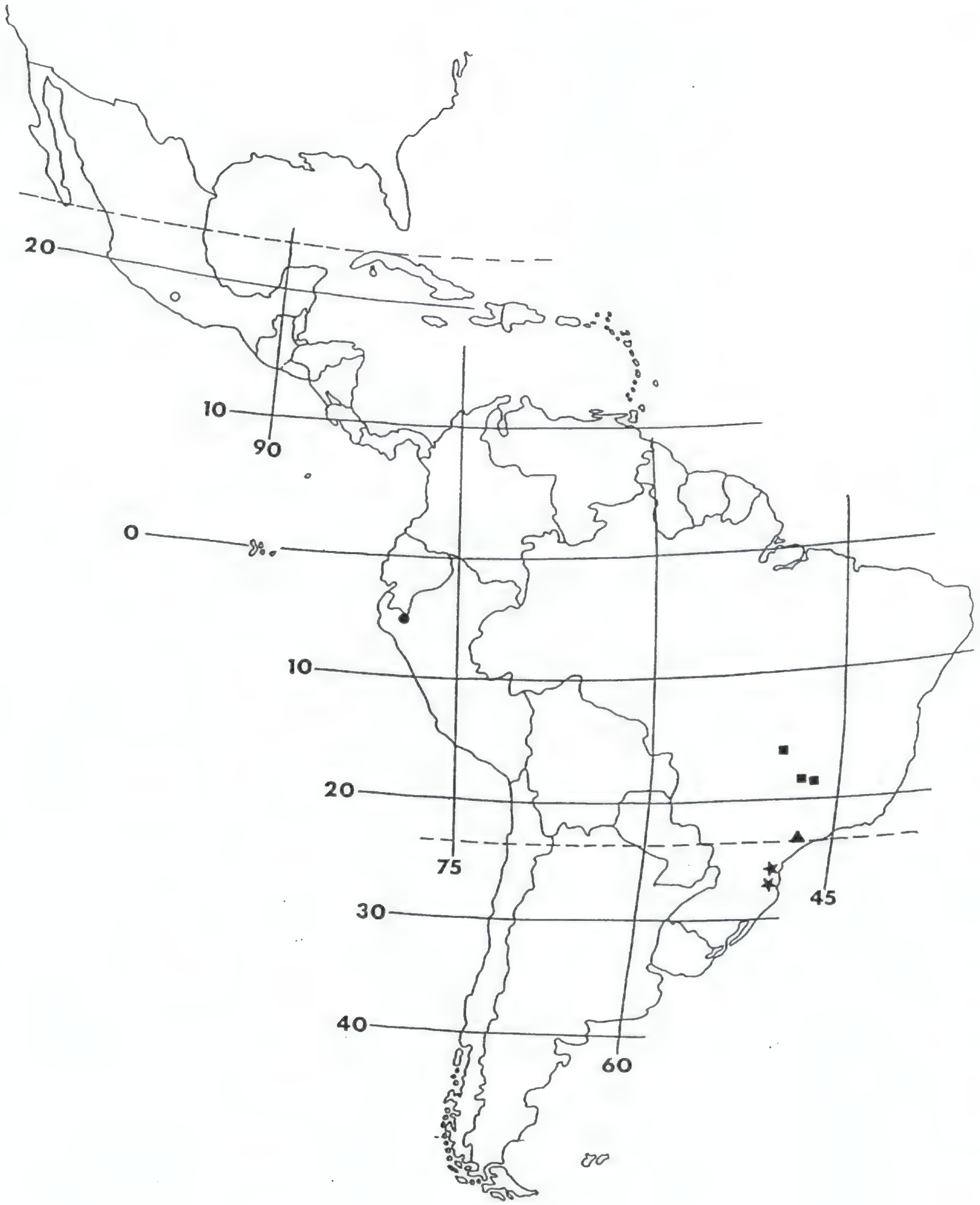


Figure 10. Known distribution of (★) *C. hatschbachii*, (■) *C. haussknechtii*, (●) *C. heterantherum*, (▲) *C. hirsutum*, and (○) *C. kruseanum*.

Specimens examined. BRAZIL. **Bahia**. Rio de Contas, Pico das Almas, vertente leste. Trilho Faz. Silvina - Queiroz, *R. M. Harley et al. 25777* (MO, MBM). **Goiás**. Serra dos Cristais, ca. 15 km W of Cristalina on road to Catalão, *H. S. Irwin et al. 13579* (UB); recullie sur le plateau central de la province de Goyaz en 1894-95, *Glaziou 22060* (C, F (2 sheets), BR, S, G); 12 km aprox. ao Oeste de Cristalina, *F. Lorea 5592* (FCME (6 dups)); 25 km W of Cristalina, *H. S. Irwin et al. 9988* (MO, NY, ENCB); 12 km aprox. ao Oeste de Cristalina, *F. Lorea 5593* (FCME (2 dups)). **Minas Gerais**. Cerrado entre Patrocinio e Coromandel, *J. Felifili et al. 91* (SPSF); Morro das Pedras, ca. 25 km NE of Patrocinio, *H. S. Irwin et al. 25534* (MO, NY); Indianapolis, fazenda Bela Tanda and neighbouring fazendas, 6 km NE of Indianapolis, *G. Gottsberger 12-11983* (MO); ca. 30 km NE of Patrocinio, *H. S. Irwin et al. 25652* (NY, MO); Patrocinio, Chapada da Pratinha, *J. Felfili et al. 43* (MO, UB); Indianapolis, Fazenda Bela Tanda and neighbouring fazendas, 6 km NE of Indianapolis, *G. Gottsberger 12-261086* (MO); **Rio de Janeiro** (?), without precise locality, *Vaulthier 397* (G).

Cinnamomum heterantherum (Ruiz & Pavón) Kostermans, Reinwardtia 6: 21. 1961.

Laurus heteranthera Ruiz & Pavón, Fl. Per. IV, t. 364. 1802. Type. Peru. Without precise locality, *Ruiz & Pavón s/n* (syntypes, BM!, F!, G! (3 sheets)).

Phoebe ruiziana Nees, Linnaea 21: 489. 1848.

Phoebe heteranthera (Ruiz & Pavón) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 185. 1889.

Tree (?); twigs ridged, turning terete soon with age, more or less pubescent, hairs 0.1-0.25

mm long, straight, appressed; petiole (8) 10-13.5 mm long, 0.9-1.3 mm wide, sparsely pubescent to glabrescent, hairs as on twigs; leaf blades (3.5) 6-9.5 cm long, (1.5) 3-4.5 cm wide, ovate to elliptic, base obtuse, apex acute to acuminate, inconspicuously pubescent above and below, hairs straight, appressed, turning glabrescent with age, pinninerved, midvein impressed above, at least on the lower third, sparsely pubescent, strongly raised below, pubescent, secondary veins 5-7 (8) pairs, rather flat above, glabrescent to glabrous, slightly raised below, sparsely pubescent to glabrous, tertiary veins flat above and below, glabrous, primary domatia present, 3-4 pairs, concave below, slightly to conspicuously ampullose above, hairy, hairs striaght, spreading to parallel to leaf blade, raising mainly from the vein walls; inflorescence 3-4.5 (7) cm long, mainly axillary to deciduous bracts on short axillary branches or at the base of developing season branches, less often single and axillary to leaves, peduncle 0.5-1.5 cm long, conspicuously pubescent, rachis pubescent, flower pedicel 2.3-3.3 mm long, pubescent; flowers urceolate, tepals 2.2-2.8 mm long, 1.4-1.8 mm wide, ovate or elliptic, pubescent outside, sericeous inside, stamens of whorls I & II 1.7-2 mm long, filaments sericeo-villose adaxially and (sparsely so) abaxially, anthers ca. 1 mm long, sericeo-pilose adaxially on lower half of connective, sporangia four, introrse, stamens of whorl III 1.9-2.1 mm long, filaments sericeo-villose adaxially and abaxially, anthers ca. 0.7 mm long, sericeo-villose adaxially, glabrous abaxially, sporangia two, latrorse-extrorse, glands 0.4-0.6 mm long, on filament, close to middle part, sericeous adaxially, glabrous abaxially, staminodes 1.4-1.6 mm long, filament sericeo-villose adaxially and (densely so) abaxially, head 0.8-1 mm long, triangular ovate in outline, sericeous adaxially on center, sericeo-villose abaxially, mainly on lower half, hypanthium 0.3-0.5 mm deep, pubescent outside, sericeous inside, pistil 2.4-2.6 mm long, ovary ca. 1.3 mm long, 1 mm wide; fruit not known,

tepals apparently persistent.

There are no data about the time of flowering, neither on the habitat conditions where this species grows.

C. heterantherum is one of the species considered in this study that stands in the boundary between the genera *Ocotea* and *Cinnamomum*. Its affinity to the latter one, however, is stronger for the presence of domatia. Even its pinninerved leaves resemble some collections of *C. triplinerve* from Colombia and some Caribean islands where this feature is found. Yet, the combination of this character along with the reduction of sporangia in the anthers of whorl III, gives it enough distinctiveness to consider it a different species.

It is not clear why it hasn't been collected again during the last two hundred years. One possibility is that since stamens and staminodes do not remain in the fruit, it has been misidentified and filed under a different genus.

Cinnamomum hirsutum Lorea-Hernández, sp. nov. TYPE: Brazil. São Paulo, Serra da Cantareira, 20 March 1969, (fl), *B. Braga 36* (holotype, SPSF; isotypes, FCME, MO).

Arbores. Folia obovata vel oblanceolata, apice acutato vel acuminato, triplinervia aut subtriplinervia, infra hirsuta trichomatibus subrectis, erectis; domatiis praesentibus ad axillas nonnullas venarum secundariarum et tertiariarum, saepe inconspicuis, pagina foliari ad domatia infra subplana, supra leviter prominens. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis carens. Flos tepalis extus sicut pedicello tomentosis, hypanthio intus

pubescente; tepalis integris in fructu persistentibus.

Trees; twigs densely hirsute, hairs 0.4 - 0.6 mm long, rather erect, straight or slightly wavy; petiole (5.5) 8 - 12 (13.5) mm long, (0.8) 1 - 1.4 mm wide, densely hirsute, hairs as on twigs; leaf blades (4) 7 - 10.5 (12.5) cm long, (2) 2.5 - 4 (5.5) cm wide, obovate to oblanceolate, apex acute to acuminate, base acute to short attenuate, hirsute-tomentose above when young, glabrescent or glabrous with age, hirsute below, hairs as on stems, persistent, triplinerved or subtriplinerved, midvein sunken above, usually hirsute-tomentose, strongly raised below, densely hirsute, hairs erect, straight, persistent, secondary veins 4 - 5 pairs, well marked above, rather glabrous, strongly raised below, densely hirsute, tertiary veins flat above, glabrous, raised below, hirsute, primary and secondary domatia present but not distinct on lower surface, however, axils of several secondary and tertiary veins slightly swollen on upper surface; inflorescences (2) 3 - 5.5 cm long, axillary to leaves, cymose-paniculate, usually last branchings congested, peduncle 0.2 - 0.7 (1) cm long, densely tomentose, rachis densely tomentose, flower pedicel 1.1 - 1.8 mm long, tomentose; flower urceolate, tepals 2.2 - 3 mm long, 1.4 - 2 mm wide, ovate, tomentose outside, densely sericeous inside, red hairs present, abundant on inner tepals, stamens of whorls I & II 1.8 - 2 mm long, filaments sericeous on lower half adaxially, sericeous abaxially, anthers ca. 1 mm long, glabrous adaxially, sericeous on lower half along median section abaxially, sometimes sparsely pubescent toward the margin, theacae four, in two pairs, introrse, stamens of whorl III 2 2.2 mm long, (stiff) sericeous adaxially, red hairs abundant, long sericeous on lower half abaxially, anthers ca. 1 mm long, sericeous all over adaxially, hairs mainly red, glabrous abaxially, sporangia four, in two pairs, upper ones latrorse, lower ones extrorse, glands 0.5 mm

long, at filament base, ovate, glabrous except for attachment point adaxially, staminodes 1 mm long, filament red hairy adaxially, long sericeous abaxially, head 0.8 mm long, wide ovate-cordate, glabrous adaxially, densely long sericeous abaxially, some red hairs present, hypanthium 0.4 - 0.5 mm deep, tomentose outside, red sericeous inside, pistil 1.9 - 2.2 mm long, glabrous, ovary 0.9 - 1.1 mm long, 0.7 - 0.9 mm wide; fruit 9.5 - 10.5 mm long, 6 - 7 mm wide, ellipsoid, cupule 5.2 - 6.2 mm long, ca. 4 mm wide, tepals persistent.

Flowers in March, fruits (still young) in May. Growing in *Araucaria* forest, altitude was not recorded, but probably grow between 800-1000 m. So far this species is known just from the two collections referred here, from the forest reserve just north of São Paulo city in Brazil.

Paratype. BRAZIL. **São Paulo**: Serra da Cantareira, estrada da Chapada, (fr), *J. Baitello & O. Aguiar s/n* (FCME, SPSF).

At first sight *C. hirsutum* looks very similar to *C. glaziovii* and *C. pseudoglaziovii*, but the long rather erect hairs covering twigs, leaves, inflorescences, and flowers, as well as the persistent tepals in fruit, distinguish it clearly from the other two.

Cinnamomum kruseanum Téllez-Valdés & Villaseñor, Novon 3: 208. 1993. Type. Mexico. Guerrero: Agua de Obispo, Puente El Mosco, *H. Kruze 620* (holotype, MEXU; isotypes, ENCB, MEXU, MO).

Small trees, up to 3 m tall; twigs densely cinereous-strigulose to velutinose; petiole 2 - 4 mm long, densely pubescent, as twigs; leaf blades 6.3 - 11.9 cm long, 3.8 - 4.8 cm wide, ovate-lanceolate or ovate, apex acute, base cordate, amplexicaulous, cinereous-strigulose to glabrescent above, densely cinereous-velutinous below, leaf surface concealed, pinninerved or subtriplinerved, midvein slightly marked above, raised above, secondary veins 3 - 4 pairs, flat above, raised below, tertiary veins inconspicuous, domatia absent (?); inflorescence up to 13 cm long, axillary to leaves, peduncle 3 - 8 cm long, velutinose, flower pedicel 6 - 13 mm long, velutinose; flowers urceolate, tepals 1 - 2 mm long, ca. 1 mm wide, ovate-lanceolate, densely canescent outside, sriceous inside (?), stamens of whorls I & II ca. 1.5 mm long, filaments glabrous ad and abaxially (?), sporangia four, stamens of whorl III ca. 1.5 mm long, filaments long sericeous adaxially, glabrous (?) abaxially, glands ca. 0.5 mm long, glabrous, staminodes ca. 0.8 mm long, filament short, head ca. 0.5 mm long, deltoid to ovate, glabrous adaxially, long sericeous abaxially, hypanthium ca. 1 mm (?) deep, pistil ca. 2 mm long, glabrous, ovary ca. 1 mm long; fruit 8 - 10 mm long, 6 - 8 mm wide, ellipsoid, pedicel 10 - 15 mm long, tepals persistent.

Flowers and fruits in March. Growing (very likely) in oak-pine forest, at an altitude of 850 - 950 m. This species is known only from the type locality.

Although Téllez-Valdés & Villaseñor (1993) suggested (by leaf shape and insertion) a relationship with *C. amplexicaule*, *C. kruseanum* has a totally different type of indument from that species. Instead, I consider *C. kruseanum* related to *C. velvetii*, a sympatric species with the same type of indument. Still it is not certain that these two species are really different from each

other, but presently with the few specimens at hand there is no possibility to work this problem out. See comment under *C. velvetii*.

Cinnamomum leptophyllum Lorea-Hernández, sp. nov. TYPE: Mexico. Veracruz: Mpo. Atzalan, Ranchito El Caballo, 1000 m, (fl, fr), 7 May 1976, *F. Ventura 12740* (holotype, ENCB; isotype, FCME).

Frutices vel arbusculae. Folia elliptica, apice caudato, subtriplinervia aut triplinervia (vel pinnatinervia), infra glabra; domatiis plerumque praesentibus, ad axillas venarum secundariarum paris basalis tantum, pagina foliari ad domatia infra concava, supra subplana vel leviter prominens. Inflorescentia ex cyma solitaria constans, bracteis foliaceis carens. Flos tepalis extus glabratis, pedicello glabro; hypanthio intus pubescente; tepalis integris in fructu persistentibus.

Shrubs or small trees (?) up to 5 m tall; twigs glabrous or sparsely pubescent close to terminal bud, hairs 0.15 mm long, straight, appressed; petiole (3.5) 4.5 - 7 mm long, 0.4 - 0.8 mm wide, glabrous; leaf blades (3.5) 5 - 7 (8.5) cm long, (1.3) 2 - 3 (3.5) cm wide, elliptic, apex caudate, base acute, glabrous above and below, subtriplinerved, often triplinerved or pinninerved, midvein slightly marked above, slightly raised below, glabrous, secondary veins 4 - 5 (6) pairs, flat above, slightly raised below, particularly lowest pair, tertiary veins rather inconspicuous, flat above, almost flat below, primary domatia present, usually only lowest pair, sometimes absent, concave below, flat or sometimes slightly raised above, secondary domatia absent; inflorescence 2 - 4 cm long, axillary to leaves or to tiny deciduous bracts, a single 3-flowered cyme, peduncle 1

- 2.5 cm long, glabrous, flower pedicel 8 - 12.5 mm long, glabrous; flowers urceolate, yellowish, tepals 1.3 - 1.5 mm long, 1.3 - 1.7 mm wide, widely ovate or ovate, glabrous outside, sericeous inside, outer ones sometimes sparsely so, some scattered red hairs present, stamens of whorls I & II ca. 1 mm long, filaments sparsely sericeous at the very base ad and abaxially, anthers 0.7 mm long, glabrous ad and abaxially, sporangia four, in two pairs, intorse, stamens of whorl III 1.1 mm long, filaments sparsely sericeous ad and abaxially at the very base, anthers 0.6 - 0.7 mm long, glabrous ad and abaxially, sporangia four, in two pairs, upper ones latrorse, lower ones extrorse-latrorse, glands 0.3 - 0.4 mm long, at about the middle part of the filament, rather abaxial on filament, rounded, sparsely sericeous adaxially at point of attachment, glabrous abaxially, staminodes 0.8 mm long, pedicels sericeous ad and abaxially, head 0.5 - 0.6 mm long, narrow cordate-triangular in outline, glabrous adaxially, sparsely (long) sericeous abaxially, hypanthium 0.5 mm deep, glabrous outside, sericeous inside, some red hairs present, pistil 1.7 - 1.9 mm long, glabrous, ovary 0.7 - 0.9 mm long, 0.6 - 0.7 mm wide; fruit 12 - 15 mm long, 0.8 - 0.9 mm wide, ellipsoid, cupule 7 - 13 mm long, 2.7 - 3.8 mm wide, pedicel 4 - 6 mm long, 0.5 - 0.6 mm wide, tepals persistent.

Flowers and ripe fruits in May. Growing in oak forest, between an altitude of 800 - 1000. Collected in wet gullies. *C. leptophyllum* is known just from a small area in the western Sierra Madre, Mexico.

Paratype. MEXICO. **Veracruz**: Mpo. Atzalan, Arroyo Colorado, 800 m, (fr), *F. Ventura 12572* (ENCB, FCME).

The combination of rather thin leaves (from which the name is derived), caudate, glabrous, and domatia hairs dense and erect to parallel to leaf surface, keep this species distinct from others in the area. Perhaps morphologically the closest species to *C. leptophyllum* is *C. ampullaceum*, which has thick leaves with pubescent lower surface, and domatia with sparse hairs mainly parallel to leaf surface.

Cinnamomum longipes (I. M. Johnston) Kostermans, Reinwardtia 6: 21. 1961.

Phoebe longipes I. M. Johnston, Contr. Gray Herb. 70: 69. 1924. Type. Mexico. Hidalgo: Acaxochitlán, Barranca Trinidad, below Honey Station, 6 May 1904, *Pringle 8829* (holotype, GH!; isotypes, F!, LL!, MICH!, MO!, US!).

Trees (?) up to 6 m tall; twigs ridged to winged from petiole insertions, glabrous or glabrescent, hairs ca. 0.2 mm long, straight, appressed; petiole (9.5) 12.5 - 22.5 (25) mm long, (0.5) 0.9 - 1.3 (1.5) mm wide, glabrous; leaf blade (4.5) 7.5 - 16 (22.5) cm long, (1) 2 - 4 (5.5) cm wide, lanceolate or, few times, elliptic, apex acuminate to long acuminate, base acute or obtuse, glabrous on both sides, sparsely pubescent below when young, hairs 0.2 - 0.3 mm long, straight, appressed, triplinerved or subtriplinerved, midvein slightly depressed above, glabrous, raised below, glabrous or sparsely pubescent, secondary veins (5) 6 -7 (8) pairs, marked above, slightly raised below, glabrous, tertiary veins flat above, slightly raised below, glabrous, primary domatia present, only at axils of lower most pair of secondaries, frequently only one or none, secondary domatia absent; inflorescence (3) 5 - 10 (13.5) cm long, axillary to leaves, or

Figure 12. Known distribution of (★) *C. leptophyllum*, (■) *C. longipes*, (●) *C. napoense*, (▲) *C. neurophyllum*, and (○) *C. pachypodum*.

sometimes to small bracts, racemiform, few times basal dichasia present, pauciflorus, filiform bracts often present at main branching points, peduncle (2) 3 - 6 (7) cm long, glabrous, rachis glabrous, flower pedicel (10) 12 - 20 (24.5) mm long, glabrous; flower narrow campanulate or urceolate, tepals 2.5 - 3.2 mm long, 2 - 2.2 mm wide, ovate to widely ovate, glabrous outside, sericeous inside, stamens of whorls I & II 2 - 2.3 mm long, filaments sparsely sericeous at base ad and abaxially, elsewhere glabrous, anthers ca. 1.2 mm long, glabrous, sporangia four, stamens of whorl III 2 - 2.3 mm long, sparsely sericeous at base ad and abaxially, elsewhere glabrous, anthers ca. 1 mm long, glabrous, sporangia four, glands 0.7 mm long, at base of filament, sericeous adaxially, staminode 1.1 - 1.3 mm long, filament sericeous ad and abaxially, red hairs present, head 0.7 - 0.8 mm long, triangular to cordate in outline, glabrous, except for central lower half sparsely sericeous abaxially, hypanthium 0.5 - 0.7 mm deep, glabrous outside, sericeous inside, red hairs present, pistil 2.7 - 3 mm long, ovary 1.2 - 1.3 mm long, 1.1 - 1.3 mm wide; no mature fruits known, tepals apparently persistent.

Flowers in May; young fruits in July. In pine-oak mixed forest, at 1850 m altitude. So far only known from a small area in the western Sierra Madre, Mexico.

C. longipes is quite a distinctive species. The combination of very long pedicels, long petioles, ridged twigs, leaves mostly without domatia, and the singular character of racemiform inflorescence, is not found in any other species of this genus in America.

Specimens examined. MEXICO. **Hidalgo**. Cerca de Tehuitzila, 5 km SE de Zacualtipán, *Rzedowski 12548* (ENCB); Barranca below Honey Station, *C.G. Pringle 8829* (GH, F(2 sheets),

LL (2 sheets) , MO, MICH, US).

Cinnamomum napoense van der Werff, Ann. Missouri Bot. Gard. 78: 411. 1991. Type. Ecuador. Napo: Estación Biológica Jatun Sacha. *Palacios 2886* (holotype, MO!; isotypes, G!, NY!, US!).

Trees 5 -15 m tall; twigs fistulose, sparsely puberulous, hairs 0.1 mm long (or shorter), straight, appressed, soon glabrous or glabrescent; petioles (12.5) 20 - 40 (50) mm long, 1.3 - 2.4 mm wide, sparsely puberulous, hairs as on twigs; leaf blades (13) 17 - 30 (36) cm long, (4) 5.5 - 10 (12) cm wide, elliptic or narrow elliptic, apex acuminate to long acuminate, base , glabrous above, sparsely puberulous below, hairs as on twigs, or glabrous, pinninerved, rarely subtriplinerved, midvein sunken above, glabrous, sparsely puberulous when young, strongly raised below, sparsely puberulous, secondary veins (5) 6 - 7 (8) pairs, slightly sunken to impressed above, raised below, puberulous, tertiary veins slightly impressed to flat above, slightly raised below, domatia absent; inflorescences (5.5) 9 - 13 (15.5) cm long, axillary to leaves or at the base of axillary branches, or fascicled (comming from an atrophied axillary shoot bud), cymose-paniculate, peduncle 2 - 8 (11) cm long, sometimes absent, puberulous, rachis puberulous, flower pedicel (2.3) 3 - 4.5 (5.5) mm long, puberulous or glabrescent; flowers pale yellow or pale yellowish white, tepals 2.1 - 2.3 mm long, 1.3 - 1.8 mm wide, ovate, external ones sparsely puberulous outside, inner ones puberulous outside, short sericeous inside, stamens of whorls I & II 1.4 - 1.8 mm long, filament sparsely puberulous along median section adaxially, puberulous abaxially, anthers 0.8 mm long, glabrous ad and abaxially, sporangia four, introrse,

stamens of whorl III 1.5 - 1.9 mm long, filament sparsely puberulous along median line and margins adaxially, puberulous or glabrescent abaxially, anthers 0.7 mm long, sparsely puberulous adaxially at the base, glabrous abaxially, sporangia two, extrorse-latrorse, glands 0.4 - 0.6 mm long, at filament base, glabrous ad and abaxially, staminodes 0.8 - 1 mm long, filament sparse to densely sericeous ad and abaxially, head 0.6 mm long, triangular, base shallow cordate, glabrous adaxially, sparsely sericeous abaxially at the base, hypanthium 0.8 - 1.1 mm deep, glabrous to sparsely puberulous outside, sericeous inside (sometimes sparsely so) inside, pistil 1.9 - 2.5 mm long, glabrous, ovary 0.8 - 1 mm long, ca. 1 mm wide; fruit 16 - 18 mm long, 9 - 11.5 mm wide, ellipsoid, cupule 7.5 - 12 mm long, 10 - 11 mm wide, narrowing to a base ca. 1.8 mm wide, or with a thick cilindrical pedicel 5 mm long, 3 mm wide, tepals partially persistent.

Flowers are present in August and September; ripe fruits are present from November through January. Tropical rain forest is the habitat where this species grows, between 250 - 450 (1200) m of altitude. So far this species is known from the Amazonian lowlands of Ecuador.

The presence of fistulose twigs, leaves mostly pinninerved, anthers of whorl III with two sporangia, and tepals partially persistent in fruit distinguish this species from the morphologically close *C. chavarriana* and *C. hammeliana*. See also comments under *C. formicarium*.

Specimens examined. ECUADOR. **Napo**. Estación Biol. Jatun Sacha, 8 km al este de Misahualli, río abajo en la margen derecha del Río Napo, *W. Palacios 2886* (G (4 sheets), MO, US, NY); Estación Biol. Jatun Sacha, *C. Cerón & M. Cerón 4718* (G, MO); margen derecho del

Río Napo, 8 km de Puerto Misahualli, *W. Palacios 2979* (G, MO); Cantón Tena, Estación Biol. Jatun Sacha, Río Napo, 8 km al E de Misahualli, *W. Palacios 4396* (G, MO); Carretera Hollio-Loreto, km 32, 8 km al W de Guamani., *D. Neill et al. 8605* (MO); Estación experimental INIAP-Payamino, Reserva Florística El Chuncho, *J. Zaruma 611* (MO); Cantón Archidona, Carretera Hollin-Loreto, entre Avila y Loreto, Huiruno, comunidad Quichua, *C. Cerón 7867* (MO); Cantón Tena, Estación Biol. Jatun Sacha, Rio Napo, 8 km al este de Misahualli, *W. Palacios 4763* (MO); Reserva Biol. Jatun Sacha, Río Napo, 8 km río abajo de Misahualli, margen derecha, *W. Palacios 1316* (MO); Cantón Tena, Estación Biol. Jatun Sacha, 8 km al este de Misahualli, *C. Cerón 5970* (MO).

Cinnamomum neurophyllum (Mez & Pittier) Kostermans, Reinwardtia 6: 22. 1961.

Phoebe neurophylla Mez & Pittier, Bull. Herb. Boissier, ser. 2, 3: 231. 1903. Type. Costa Rica. Diquis Valley, by river Hur, *Pittier 12054* (holotype, B, n.v.; isotypes, G!, P!, US!).

Trees 10 - 18 m tall; twigs, minute and inconspicuously pubescent, hairs 0.1 (0.2) mm long, straight, appressed, soon glabrous; petioles (6) 11.5 - 21.5 (30) mm long, (1.2) 1.5 - 2.5 (3) mm wide, sparsely pubescent, hairs as on twigs, soon glabrous; leaf blades (6.5) 12 - 23.5 (30.5) cm long, (2) 4 - 7.5 (10.5) cm wide, narrowly elliptic or elliptic, apex acute to short acuminate, base acute to short attenuate, sparsely pubescent above and below when young, soon glabrous on both surfaces, triplinerved or slightly subtriplinerved, midvein sunken above, pubescent when young, soon glabrous, strongly raised below, glabrescent, hairs as on twigs, secondary veins 3 - 4

Figure 11. Flowering branchlet of *C. neurophyllum*.

(5) pairs, basal pair sharply ascending, parallel to leaf margin most of their length, sunken above, strongly raised below, glabrescent or glabrous, other secondaries much less conspicuous, slightly raised below, tertiary veins flat above, glabrous, distinct but rather flat below, glabrous, primary domatia present, just the lowest pair, secondary domatia absent; inflorescence (3.5) 6 - 11 (15.5) cm long, axillary to tiny deciduous bracts, and disposed in very short racemes, cymose-paniculate, peduncle (1) 3 - 6 (8.5) cm long, sparsely pubescent to glabrescent, rachis glabrescent to glabrous, flower pedicel (3) 4 - 6 (7.5) mm long, glabrous or glabrescent; flower urceolate, tepals 1.8 - 2.5 mm long, 1.2 - 1.9 mm wide, ovate, glabrous outside, sericeous inside, outer ones sparsely so, stamens of whorls I & II 1.5 - 2 mm long, glabrous or sparsely sericeous adaxially, glabrous to sparsely sericeous abaxially, anthers 0.8 - 0.9 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 1.5 - 2 mm long, filaments sparsely sericeous or glabrescent adaxially, glabrous abaxially, anthers 0.6 - 0.7 mm long, glabrous ad and abaxially, sometimes sparsely sericeous on lower half adaxially, sporangia four, upper ones latrorse, lower ones latrorse-extrorse, glands 0.5 - 0.7 mm long, at filament base, wide ovate, glabrous ad and abaxially, staminodes 0.8 - 1.3 mm long, filaments sparsely long sericeous ad and abaxially, head 0.5 - 0.9 mm long, ovate-triangular in outline, glabrous ad and abaxially, hypanthium 0.3 - 1 mm deep, glabrous outside and inside, pistil 1.5 - 2.8 mm long, ovary 0.9 - 1.4 mm long, 0.7 - 1.1 mm wide; fruit 13 - 21 mm long, 8 - 14 mm wide, ellipsoid, cupule 9 - 16.5 mm long, 8.5 - 11 mm wide, gradually narrowing to a bottom 1.2 - 2 mm wide, pedicel not distinct, tepals partially persistent.

Flowers are present from January to March, and ripe fruits from late June to August. No

information on the natural vegetation where this species occurs has been recorded. But it grows in lowland areas (probably with tropical rain forest), between an altitude of 80 - 800 m. Its geographic distribution spans from Honduras (Nicaragua (?)), to Costa Rica.

As mentioned above, *C. costaricanum* and *C. neurophyllum* are morphologically very similar. But, in addition to the differences mentioned under comments of *C. costaricanum*, the fact that they grow also at altitudinal ranges that do not overlap, supports accepting them as two distinct taxa.

Specimenes examined. COSTA RICA. **Alajuela**. Reserva Biológica Monteverde Río Peñas Blancas, Finca Wilson Bandilla, *E. Bello 779* (MO(2 sheets)). **Limón**. La Aurora, Guácimo, ca. 5 km al E del pueblo, sobre el Río Sierpe, frente al puesto del P.N. Tortuguero, *R. Robles 2083* (MO); **Puntarenas**. Fila before Rancho Quemada, near Rincón, Osa Peninsula, *A. Gentry et al. 78676* (MO(2 sheets)); Osa, Rincón, Rancho Quemado, camino a Chiquerón, *G. Herrera 5013* (MO (3 sheets)); Osa, Rancho Quemado, Sector norte, camino a Cerro Chocuaco, *J. Marin 438* (MO (4 sheets)); Osa Peninsula, Aguabena, *K. Thomsen 299* (MO); Golfito Fila Gamba, camino entre Golfito y Villa Briceno, *N. Zamora 1919* (MO (3 sheets)); Osa, Rincón de Osa, Agua Buena, *Q. Jiménez 947* (MO (4 sheets)); Osa Peninsula, Aguabena, *K. Thomsen 739* (MO); Osa Peninsula, Aguabena, *K. Thomsen 942* (MO); Bords du Rio Hur, bassin du Diquis, *H. Pittier 12054* (P, US, A, G). **San José**. Vicinity of El General, *A. F. Skutch 3844* (NY, MO, S); Basin of El General, *A. F. Skutch et al. 5116* (MO, NY, F); Vicinity of El General, *A. F. Skutch 4329* (MO, NY, S, F). HONDURAS. In deep forest near Lancetilla, *T. G. Yuncker 4945* (MO, F, NY).

Cinnamomum pachypodum (Nees) Kostermans, Reinwardtia 10: 447. 1988.

Persea pachypoda Nees, Linnaea 21: 490. 1848. Type. Mexico. Hidalgo: Agua Blanca de Iturbide (?), El Banco, between Apulco and San Cornelio *Ehrenberg 942* (holotype, B, n.v.; isotypes, F!, GZU!).

Phoebe pachypoda (Nees) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 196. 1889.

Oreodaphne benthamiana Nees, Linnaea 21: 521. 1848. Type. Mexico. Guanajuato: near Guanajuato, Mar - Apr 1837, *Hartweg 84* (holotype B!; isotypes, BM!, G!, P!).

Phoebe benthamiana (Nees) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 195. 1889.

Phoebe hartwegii Meissner, in DC. Prodr. 15: 30. 1864. Type. Based on same collection as type of *Oreodaphne benthamiana*. Nom. illeg.

Persea hartwegii (Meissner) Hemsley, Biol. Centr. Amer. III: 72. 1882. Nom. illeg.

Phoebe ehrenbergii Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 201. 1889. Type. Mexico. Mexico: Temascaltepec, *Ehrenberg 712* (holotype, B not seen; isotype, F! (a leaf and a flower)).

Cinnamomum ehrenbergii (Mez) Kostermans, Reinwardtia 6: 21. 1961.

Phoebe arsenei C.K. Allen, J. Arnold Arbor. 26: 312. 1945. Type. Mexico. Michoacán: Morelia, near El Rincón, 1950 m, 11 Apr 1909, *Arsène 2448* (holotype, GH!; isotypes, MO!, NY!, P!, US!).

Cinnamomum arsenei (C.K. Allen) Kostermans, Reinwardtia 6: 20. 1961.

Trees (4) 6 - 10 (15) m, or shrubs 2 -4 (6) m tall; twigs densely velutinous, hairs 0.4 - 0.7 mm long, erect, rather straight; petiole (2.0) 6.5 - 11.0 (14.0) mm long, densely velutinous; leaf

blade (3.5) 6.0 - 11.5 (21.5) cm long, and (1.0) 2.0 - 4.5 (8.5) cm wide, elliptic, narrowly elliptic or ovate, few times obovate, apex acute, long acuminate, few times obtuse, base obtuse to acute, triplinerved or sometimes pinnately veined, with (3) 4 -6 pairs of secondary veins, upper surface sparsely velutinous to glabrous, lower surface velutinous, hairs erect, rather straight, secondary veins densely velutinous below; primary domatia usually not evident, secondary domatia absent; inflorescence 3.5 - 11.0 (17.5) cm long, axillary to leaves or to small deciduous bracts, then on very short branchlets or at the base of new branches, cymose-paniculate, terminal branchings sometimes irregular, sparsely velutinous, often glauco-ceraceous, flower pedicel (2.5) 4.0 - 7.5 (11) mm long, glabrous, sometimes sparsely velutinous; flowers 2.2 - 3.0 mm long, urceolate, greenish yellow, tepals 1.8 - 2.5 mm long, and 1.5 - 2.2 mm wide, ovate or widely ovate, glabrous outside, sericeous inside, the outer ones sometimes glabrescent on their upper half, stamens of whorls I & II 1.4 - 2.2 mm long, their filaments glabrous or sparsely pilose ad and abaxially, anthers glabrous, stamens of whorl III 1.5 - 2.1 mm long, their filaments sparsely pilose above on the margin and adaxially, anthers glabrous, sporangia four in all stamens, upper sporangia of whorl III stamens very few times aborted or absent, glands ca. 0.5 mm long, elliptic or rounded, staminodes 0.9 - 1.2 mm long, their filaments sparsely pilose above on the margin and adaxially, apex glabrous or sparsely pilose abaxially on the base, hypanthium 0.3 - 0.5 mm deep, glabrous outside and inside, only few times with some scattered hairs inside, ovary and style glabrous; fruit 10.0 - 15.5 mm long, and 8.0 - 12.5 mm wide, ellipsoid, seated on the persistent tepals, pedicel turbinate, reddish.

This species is found mainly in the central highlands of Mexico, north to the volcanic belt

that runs east-west across the country. It grows in rather dry areas with pine forest, oak forest, and tropical deciduous forest, between (300) 1100 and 2000 (2200) m of altitude. However, it is not uncommon to find it growing in wetter places adjacent to its usual habitat, in creeks or protected slopes with oak-pine mixed forest; places that frequently correspond to the lowest areas of its range of distribution. Flowers are present from (January) February through May (July), and ripe fruits are found from June to October (November).

C. pachypodum presents a rather wide morphological variation, with larger and softer leaves, as well as bigger inflorescences in more humid areas. The combined occurence of leaf undersurface velutinous, flowers glabrous, and fruits bore by broaden hypanthia with persistent tepals, however help to place those specimens under this name. Few specimens exist with undersurfaces that tend to be glabrescent and with shorter hairs, presenting sometimes primary domatia of the type found in *C. effusum*. Thus, all these plants are considered putative hybrids between these two species. At the same time, the specimen *H. Rubio 1663* is probably a hybrid between *C. pachypodum* and *C. bractefolium*, as the large foliose bracts in the inflorescence and glabrescent leaf undersurface with erect hairs seem to indicate. Finally, *Phoebe ehrenbergii* is included here on the basis of the presence of some specimens that have glabrous leaves, but the same type of pubescence on young branches, flowers glabrous, and entire persistent tepals in the fruit as typical *C. pachypodum*. The inclusion of this species under *C. pachypodum* is not conclusive yet, for the presence of subglabrous interior of hypanthium in *P. ehrenbergii* type.

As Mez (1889) suspected in his treatment of the American Lauraceae, *Hartweg 84* (flowering material) and *Ehrenberg 942* (fruiting material) collections are conspecific. The fragment of Ehrenberg collection filed at F has only two leaves and one loose flower bud that

obviously does not belong to it, since that collection was referred as only with fruits in Nees description of *Phoebe pachypoda.* It is very likely that this specimen is partially the source of confusion found in Allen's (1945) concept of what was, in her view, *Persea pachypoda*. She describes the species as having "...densely tomentose..." flowers, which agrees with the flower bud slipped with type fragment at F, but wholly disagrees with the glabrous flowers of *O. benthamiana* type collection (*Hartweg 84*), cited in her work as synonymous with that species. Besides that, pubescence of that loose flower is made out of short and thick reddish-brown hairs, the kind of pubescence that Allen refers to as present in leaves and inflorescence axes, yet not found in the companion pickled leaves of Ehrenberg collection. The flower seems to belong to a *Persea* species (yet tepals seem to be about the same size in the bud), to which one is open to conjecture, but definitively does not belong to any American species of *Cinnamomum*.

Fortunately, the specimen at GZU confirmed what Nees said in the description of *P. pachypoda*, and provided more information (fruit morphology, and more and bigger leaves) to conclude the connection of this and the Hartweg collection. The combination of leaves with lower surface velutinous, fruits with glabrous persistent tepals, and hypanthium glabrous inside, is not found in other species of the area. Furthermore, the now abundant collections of *Cinnamomum* from the area helped to solve the problem. There is flowering material from the area that matches Hartweg collection and, because of a wider representation of variation of morphology in the species, both the Hartweg and Ehrenberg collections are readily accomodated. The same is the case of *Arsène 2448* collection on which description of *Phoebe arsenei* was based. But in this case the inclusion of Arsène collection in *Cinnamomum pachypodum* is clearer. Pubescence and shape of leaves, flowers glabrous, and primary domatia usually inconspicuous, fit the Hartweg collection almost

perfectly. One Arsène specimen at P even has remains of fruits that connect the Hartweg and Ehrenberg collections. It is not obvious how Allen (1945) was able to put together Ehrenberg and Hartweg collections and did not find a connection between these and Arsène's.

Standley (1922) did realize that *P. pachypoda* and *O. benthamiana* were conspecific. Buthis preference for the combination *Phoebe pachypoda* over *P. benthamiana* was in some way unfortunate, since type material of *Persea pachypoda* is now scarce and fragmentary, and does not have flowers. On the other hand, type material of *Oreodaphne benthamiana* is present with good specimens in several herbaria, and it does have flowers. Type locality of *P. pachypoda* was established on the data supplied by McVaugh (1970) in the introduction to Bentham's "Plantae Hartwegianae" reprint.

Specimenes examined. MEXICO. **Guanajuato**. Near Guanajuato, *Hartweg 84* (P, G (2 sheets), B, BM); Victoria, Río Colorado, *E. Ventura & E. López 8090* (IEB); Atarjea, Aldama, *S. Zamudio 2517* (IEB (2 dups)); Xichú, El Chirimoyo, 8 km al Oeste de Xichú, *E. Ventura & E. López 6547* (IEB); Mesas de Jesús, La Ventana, *E. Ventura & E. López 7844* (IEB); Xichú, La Colorada, 8km al S de Xichú, *E. Ventura & E. López 6606* (IEB); Allende, Cañada del "Molino", *R. Santillán 687* (IEB); 13 km al W de Xichú, sobre la carretera a San Luis de la Paz, *J. Rzedowski 41554* (IEB); Victoria, Mesas del Tigre, *E. Ventura & E. López 8596* (IEB); Allende, Cañada de "El Molino", *R. Santillán 682* (IEB); San Miguel de Allende, Cañada del Agua Espinosa, *R. Santillán 349* (IEB); Xichú, Rancho Beltran, 10 km al S de Xichú, *E. Ventura & E. López 6777* (IEB); Xichú, Los Túneles, 15 km al N de Xichú, *E. Ventura & E. López 6705* (IEB); Tarimoro, alrededores del Cerro de la Bufa, Sierra de los Agustinos, *J. Rzedowski 45565*

(IEB). **Hidalgo**. Tepeji del Río, 12 km al N de Tepeji del Río, *R. Hernández M. 6618* (ENCB, MO); El Banco, between Apulco and San Cornelio, *Ehrenberg 942* (F, GZU); **Michoacán**: Morelia, Bro. *G. Arsène 2448* (MO, P (2 sheets), GH, NY); Morelia, *Arsène s.n.* (P); Morelia, alrededores de La Mintzita, *J. Rzedowski 44261* (IEB, ENCB, XAL); Morelia, Cañada del Río Filtros Viejos, al SE de Morelia, *F. Lorea & S. Zamudio 5480* (FCME (9 dups)); Tuxpan, *W. Popenas & L. Williams 14392* (F); Tuxpan, La Cañada del Puerto La Cantera, 8.7 km al O de Tuxpan., *R. Torres & M. Ramírez 13534* (IEB); Zinapécuaro, Arroyo Zinapécuaro, 500m al W del Balneario Las Adjuntas, *M.J. Jasso 841* (IEB); 2km de Pomoca, carr. a Maravatío, *H. Díaz Barriga et al. 6853* (IEB (2 dups)); Morelia, Cañada del Río Chiquito, ex hacienda El Rincón, *H. Díaz B. 6693* (IEB, MO (2 sheets)); Morelia, Cañada del Río Grande, cerca de Cointzio, *H. Díaz B. & E. Pérez C. 6949* (IEB). **Puebla**. Barranca al S de Huauchinango, *Sharp & Miranda 3478* (MEXU). **Querétaro**. Arroyo Seco, aprox. 4 km al SSE de El Tepozán, *E. Carranza 1935* (IEB); Arroyo Seco, aprox. 6-7 km río abajo de El Trapiche, Río Jalpan, *E. Carranza 1536* (IEB); Landa, cerca de Rincón de Peña Blanca, próximo a Tilaco, *J. Rzedowski 49449* (IEB (2 sheets)); Pinal de Amoles, aprox. 4 km al SE de Sta. Agueda, *E. Carranza 1639* (IEB); San Juan del Río, 2 km al SW de Puerta de las Alegrias, *R. Fernández N. 2849* (ENCB); Landa, 1 km al Poniente de San Onofre, *H. Rubio 439* (IEB); Camino entre carr. a México y Amealco, km. 18 aprox., *E. Argüelles 748* (MEXU); Camino entre carr. a México y Amealco, *E. Argüelles 753* (MEXU); Pinal de Amoles, 9 km al S de Santa Agueda, sobre el camino a Ahuacatlán, *Rzedowski 46643* (IEB); Arroyo Seco, aprox. 2km al W de El Jardín, *E. Carranza 1841* (IEB); Arroyo Seco, aprox. 2km de El Jardín, camino a la Florida, *E. Carranza 1481* (IEB); Arroyo Seco, aprox. 1km al S de Arroyo Seco, *E. Carranza 1489* (IEB); Arroyo Seco, al W de Agua Fría de los Fresnos, *E.*

Carranza 3043 (IEB); Amealco, El Batán, *E. Argüelles 2412* (IEB, MEXU); Landa, 1 km al SE de San Onofre, *H. Rubio 2349* (IEB); Jalpan, Aprox. 2 km al W de Jalpan, *E. Carranza 650* (IEB); Jalpan, 6 km al SE de Jalpan, sobre el camino a San Pedro Escanela, *S. Zamudio & H.Diaz B. 5248* (IEB); Jalpan, Aprox. 1 km al SW del Puerto de Animas, *E. Carranza 525* (IEB); Jalpan, Ojo de Agua, Carrizal de Los Durán, *B. Servin 1143* (IEB); Jalpan, Aprox. 5 km al WSW de El Lindero, *E. Carranza 1113* (IEB); Landa, aprox. 5 km de El Lobo, camino a Agua Zarca, *E. Carranza 697* (IEB (2 dups)); Landa, Los Tubos, 2.5 km al SE de San Juan, *H. Rubio 2362* (IEB); Landa, 1 km al SE de Neblinas, *H. Rubio 2247* (IEB); Jalpan, aprox. 2 km al NE de El Embarcadero, *E. González 1458* (IEB); Landa, 2 km al W de Neblinas, Canon del Río Tancuilín, *F. Lorea 5554* (FCME (11 dups)). **San Luis Potosí**. 22 km W of Santa Catarina on hwy. 86 at km 49, *K. Roe & E. Roe 2163* (NY); By stream Las Canoas, *C. G. Pringle 3783* (MEXU (2 sheets), A, BR (2sheets), C, G, F); Zaragoza, alrededores de La Salitrera, *Rzedowski 11415* (ENCB). **Veracruz**. Chicontepec, Poblado de Tlacolula., *J. I. Calzada 5624* (F); Tepetzintla, Tierra Blanca, camino para la Sierra de San Juan Otontepec., *J. I. Calzada 5524* (F); Cerro del Cebollal, arriba de Campeche, San Andrés de Tuxtla, *J. I. Calzada 603* (F); Chiconquiaco, Arroyo Resbaloso, *F. Ventura 5256* (ENCB (2 sheets)); Banderilla, *M. Acosta & J. Dorantes 175* (ENCB); Alto Lucero, Rancho Nuevo, *G. Castillo C. & F. Vazquez 1513* (F).

Cinnamomum padiforme (Standley & Steyermark) Kostermans, Reinwardtia 6: 22. 1961.

Phoebe padiformis Standley & Steyermark, Publ. Field Mus. Nat. Hist., Bot. ser. 23: 117. 1944.

Type. Guatemala. Quezaltenango: Colomba, October, 1934, *Skutch 1367* (holotype, F!;

isotype, A! (2 sheets), BM!, G!, NY!, US!).

Trees 6 - 15 (25) m, or shrubs (?) 2 - 6 m tall; twigs rather terete, conspicuously pubescent, hairs 0.3 - 0.5 mm long, spreading to more or less erect, more or less straight to wavy; petioles (5) 7 - 10 (12) mm long, (0.6) 7 - 1 (1.3) mm wide, pubescent when young, glabrescent with age, hairs as on twigs; leaf blades (3.5) 5.5 - 9 (11) cm long, (1) 2 - 3.5 (4.5) mm wide, elliptic to narrow elliptic, apex acute to acuminate, base acute, pubescent above when young, soon glabrous, pubescent below, hairs as on twigs, rather falling off soon or more or less persistent in some areas, triplinerved, subtriplinerved or pinnate, midvein slightly marked to flat above, pubescent when young, glabrous or more or less pubescent at base later, raised below, conspicuously pubescent, hairs erect, mostly deciduous, secondary veins 4 - 6 pairs, flat above, glabrous, raised below, glabrescent or glabrous, tertiary veins flat above, slightly raised below, as well as minor veins, forming a conspicuous reticulum, primary domatia present on most of secondaries' axils, secondary domatia mostly present, often along several secondaries pairs; inflorescence (1.5) 3 - 6 (10) cm long, axillary to leaves, the last ones sometimes small and deciduous, cymose-paniculate, often few branching cymes along the rachis, peduncle (1) 1.5 - 3.5 (4.5) cm long, pubescent or sparsely pubescent, flower pedicel 2.5 - 4.5 (7) mm long, glabrous or sparsely pubescent; flowers urceolate, pale yellowish white, tepals 1.6 - 2.6 mm long, 1.2 - 1.8 mm wide, ovate or wide ovate, pubescent or sparsely pubescent outside, rarely glabrous, sericeous inside, outer ones sometimes glabrescent towards the margin, stamens of whorls I & II 1.2 - 1.8 mm long, filaments glabrous or sparsely pubescent along median section ad and abaxially, anthers 0.7 - 1 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens

of whorl III 1.2 - 1.7 mm long, filaments dense to sparsely sericeous adaxially, sparsely pubescent at base abaxially, anthers 0.6 - 0.8 mm long, sparsely pubescent at base of connective adaxially or wholly glabrous, glabrous abaxially, sporangia four, upper ones latrorse, lower ones latrorse-extrorse, glands (0.3) 0.5 mm long, well above filament base, ovate, sparse sericeous adaxially, glabrous elsewhere, staminodes 0.7 - 1 mm long, filament densely sericeous or glabrescent adaxially, sparsely sericeous abaxially, head 0.7 - 0.5 mm long, ovate in outline, acute, glabrous adaxially, sparsely long sericeous on lower half abaxially, hypanthium 0.3 (0.5) mm deep, glabrous or sparsely pubescent outside, glabrous inside or few sericeous hairs present on upper half, pistil 1.7 - 2.1 mm long, glabrous, ovary 0.8 - 1.1 mm long, 0.8 - 1 mm wide; fruit 9 - 13 mm long, 4.5 - 9 mm wide, ellipsoid, cupule 5 - 8.5 mm long, 3.5 - 5 mm wide, sometimes narrowing gradually to a bottom 1.3 - 1.8 mm wide, pedicel 1.7 - 3 mm long, 0.8 - 1.6 mm wide, sometimes indistinct, tepals persistent.

Individuals of this species have been found flowering in May, June, August and October, but it is not clear whether the species presents a continuous period of flowering throughout those months or if it has two peaks of flowering. Ripe fruits are present from January through April. The type of vegetation where this species occurs includes oak forest, pine forest, pine-oak forest, oak-*Podocarpus* forest, and cloud forest, between (600) 1200 - 2100 m altitude. As considered here, *C. padiforme* has two separate areas of distribution: one in western Mexico, and the other in Central America from Guatemala to Nicaragua.

Type material of *Phoebe padiformis* resembles *C. effusum*, but pubescence made of rather spreading to erect hairs, and presence of domatia along several pairs of secondary veins,

distinguish the former from the latter one. Most of the specimens assigned to *C. padiforme* match type material, yet there is some variation for pubescence in the inflorescences and flowers, that might in the future (with more collections) be the base for segregating one more taxon.

Specimens examined. GUATEMALA. **Chiquimula**. Upper slopes of Montaña Tajurán, in vicinity of El Barriol., *J. A. Steyermark 30853* (F). **Quezaltenango**. Colomba, *A. F. Skutch 1367* (F, A, US, NY, BM, G); Colomba, *A. F. Skutch 1358* (A, NY, F, BM, G). HONDURAS. **Comayagua**. Cordillera de Montecillos, Montaña de San Juanillo, trail between Cerro San Juanillo and La Danta, *G. Davidse & T. Hawkins 34192* (MO (4 sheets)); Base of south to east slopes of Cerro Cuchilla Alta, Reserva Biológica Cordillera de Montecillos, *R. Evans 1124* (MO); San Juanillo, Cordillera de Montecillos Biological Reserve Forest., *R. L. Liesner 26782* (MO (7 sheets)). **El Paraíso**. Pinares de Montaña Agua Fría, *A. Molina 7387* (G). **Intibuca**. Bosque nebuloso entre Pela Nariz y Calaveras, Cordillera Opalaca 20 km NE de La Esperanza, *A. Molina R. et al. 13974* (F); Bosque nebuloso entre Pela Nariz y Calaveras, Cordillera Opalaca 20 km NE de la Esperanza, *A. Molina R. & A. R. Molina 13945* (F); Bosque nebuloso de Calaveras, cordillera Opalaca, 6 km NO de La Esperenza, *A. Molina R. 7962* (F); In forest area between Pela Nariz and Calaveras, 12 km from La Esperanza, *A. Molina 24108* (F). **La Paz**. Las Trancas. Opatoro, *R. Felber 43* (G); Opatoro ?, *Ruedi Felber 40* (G); 4 km NW of Guajiquro, remnant patch of primary forest, *R. L. Liesner 26541* (MO); **Lempira**. Montaña de Celaque, SE part of massif, represa trail from Gracias to top of mountain, *G. Davidse & R. Zuñiga 34705* (MO (6 sheets)); Montaña de Celaque, SE part of massif, canyon of the Quebrada El Naranjo, *G. Davidse & R. Zuñiga 34647* (MO (2 sheets)); Montaña de Celaque, SE part of massif, represa

trail from Gracias to top pf mountain, *G. Davidse & R. Zuñiga 34686* (MO (2 sheets)); Celaque National Park, *H. Thomas 54* (MO (2 sheets)). NICARAGUA. **Jinotega**. Ocotillo near Sta. Lastenia, Cordillera Central de Nicaragua, *L.O. Williams et al. 27812* (F); Macizos de Peñas Blancas, top and N slope of steep ridge SW of finca of Manuel Estrada, S of Río Gusaneras, *W.D. Stevens 11555* (MO).

Cinnamomum palaciosii van der Werff, Ann. Missouri Bot. Gard. 78: 415. 1991. Type. Ecuador. Imbabura: along road Apuela-Otavalo, near Apuela, 14 February 1989, *van der Werff & Palacios 10575* (holotype, MO!; isotypes, F!, G!, NY!).

Trees up to 25 m tall; twigs more or less quadrangular, with ridges coming down from petiole bases, densely pubescent, hairs of two types, some 0.3 - 0.6 mm long, spreading upward or more or less erect, scattered, other 0.1 - 0.4 mm long, rather appressed, matted, very dense, both becoming sparse with age; petiole 19 - 32 mm long, 1.5 - 2.5 mm wide, densely pubescent, hairs appressed; leaf blades (11.5) 16 - 27 cm long, 8 - 13.5 cm wide, elliptic, few obovate, densely pubescent above when young, glabrescent soon, densely pubescent below, two types of hairs as on twigs, glabrescent with age, triplinerved or subtriplinerved, sunken and densely pubescent above, glabrescent with age, strongly raised below, densely pubescent, secondary veins 3 - 4 pairs, basal pair sunken half of their lenght above, pubescent, glabrescent with age, other pairs marked and pubescent when young, all raised below, pubescent, glabrescent with age, tertiary veins marked or flat above, pubescent, soon glabrous, slightly raised below, pubescent first, glbrescent with age, primary domatia present, secondary domatia present; inflorescence 5 -

Figure 14. Known distribution of (★) *C. padiforme*, (■) *C. palaciosii*, (●) *C. paratriplinerve*, (▲) *C. pseudoglaziovii*, and (○) *C. quadrangulum*.

17 cm long, axillary to leaves, sometimes (?) clustered just about shoot apex, cymose-paniculate, last branchings often congested, peduncle 0 - 0.5 (2.5) cm long, densely pubescent, rachis densely pubescent, flower pedicel glabrous or glabrescent; flower urceolate, greenish, tepals ca. 3 mm long, 2.2 - 2.9 mm wide, ovate to widely ovate, glabrous outside, outer ones sericeous only at base, glabrous elsewher, inner ones sericeous inside, stamens of whorls I & II 2 2.5 mm long, filaments sericeous ad and abaxially, anthers ca. 1.2 mm long, glabrous, sporangia four, stamens of whorl III 2.1 -2.5 mm long, filaments long sericeous adaxially, few red hairs present, mostly sericeous along median section abaxially, anthers 0.9 - 1.1 mm long sericeous along median section adaxially, glabrous abaxially, sporangia four, glands 0.7 - 0.9 mm long, just above filament base, densely sericeous adaxially, staminode ca. 1.8 mm long, filament long sericeous ad and abaxially, head ca. 1 mm long, cordate in outline, glabrous adaxially, long sericeous abaxially, hypanthim 0.5 - 0.6 mm deep, glabrous outside, densely sericeous inside, pistil 2.7 - 2.9 mm long, glabrous, ovary 1.1 - 1.3 mm long, ca. 1 mm wide; fruit not known.

Flowers in February. Fruits in July (very young). In high altitude forest (no particular type indicated); at 2000 m altitude. Presently known only from two collections in northern Ecuador.

This species is sharply different from the rest of the *Cinnamomum* species in the area of study. Its broad leaves with two kind of hairs on the lower surface, as well as on the twigs, are not found in any other species of the genus in America.

Specimens examined. ECUADOR. **Imbabura**. Road Otavalo-Apuela, *H. van der Werff*

et al. 10575 (MO, F, NY, G, U); Along road Otavalo-Apuela, *H. van der Werff et al. 12177* (MO (2sheets)).

Cinnamomum paratriplinerve Lorea-Hernández, sp. nov. TYPE: Costa Rica. Puntarenas: Monteverde, Santa Elena, 1400 m, (fl, young fr), 2 March 1989, *E. Bello 589* (holotype, CR; isotype, MO).

Arbores. Folia plerumque elliptica vel anguste elliptica, apice acuminato vel longe acuminato, triplinervia aut subtriplinervia, infra sparsim et inconspicue pubescentia trichomatibus rectis, adpressis; domatiis interdum praesentibus ad axillas venarum secundariarum paris basalis tantum, pagina foliari utrinque ad domatia subplana. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis nonnunquam praesentibus, satis deciduis. Flos tepalis extus glabris, pedicello glabro vel glabrato, hypanthio intus glabrescente; tepalis in fructu partim persistentibus.

Trees 6 - 15 (25) m tall; twigs ridged, two ridges coming down from petiole insertions, soon terete, pubescent, hairs ca. 0.2 (0.3) mm long, rather straight and appressed, few spreading, more or less persistent or soon falling; petioles (5) 8 - 14 (18) mm long, (0.6) 1 - 1.4 (1.7) mm wide, pubescent above, glabrescent below, hairs as on twigs; leaf blades (3.5) 7 - 12 (14.5) cm long, (1.5) 2.5 - 4 (5) cm wide, elliptic to narrowly elliptic, rarely oblanceolate or ovate, apex acuminate to long acuminate, base attenuate, glabrous above, sparsely or moderately but usually inconspicuously pubescent below, hairs appressed, more or less straight, as on twigs, triplinerved

or subtriplinerved, midvein slightly marked above, glabrous or glabrescent, raised below, sparsely pubescent, secondary veins (3) 4 - 5 pairs, flat above, glabrous, slightly raised below, glabrescent, tertiary veins flat above, almost flat below, primary domatia frequently not distinct, only one or the two of the lowest pair present, secondary domatia absent; inflorescence 4 - 8 (10) cm long, axillary to leaves, sometimes pseudoterminal, single or less often in short axillary racemes, cymose-paniculate, foliose bracts sometimes present, peduncle 0.5 - 3.5 (5.5) cm long, sparsely pubescent, rachis sparsely pubescent, flower pedicel (1.5) 2 - 4 (6) mm long, glabrescent or glabrous; flowers urceolate-campanulate, tepals 2.2 - 2.8 mm long, 1.7 - 2 mm wide, ovate, glabrous outside, outer ones sparse sericeous inside, inner ones densely sericeous inside, stamens of whorls I & II ca. 2 mm long, filaments sparsely sericeous at base adaxially and on margins, glabrous or pubescent abaxially, anthers ca. 1 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III 2 mm long, sparsely pubescent adaxially, glabrous or pubescent abaxially, anthers 0.8 mm long, glabrous ad and abaxially, sporangia four, upper ones latrorse, lower ones extrorse, glands 0.6 mm long, at base of filament, sparse tomentose adaxially, glabrous abaxially, staminodes 1.1 - 1.4 mm long, filament sericeous on upper half adaxially, glabrous or sparsely sericeous long sericeous abaxially, head 0.6 - 0.8 mm long, cordate-triangular in outline, glabrous ad and abaxially, hypanthium ca. 0.5 mm deep, glabrous outside, mostly glabrous inside, except for some hairs at the top between staminodes and third stamen bases, pistil 2.1 -2.3 mm long, glabrous, ovary 1.2 mm long, 0.9 - 1.1 mm wide; fruit 11 - 14.5 mm long, 8.5 - 10 mm wide, ellipsoid, cupule 8 - 12 mm long, 5.5 - 6 mm wide, narrowing gradually to a bottom 1.6 - 2.1 mm wide, pedicel not distinct, tepals partially persistent.

Flowers are present from March through May; fruits apparently take a long time for maturation, from August through January, but mainly in September - October. Tropical premontane forest is the natural type of vegetation where this species occurs, but it can be found also in secondary forest and pastures at an altitude between (800) 1100 - 1600 m. This species is known from central Costa Rica to western Panama.

Paratypes. COSTA RICA. **Guanacaste**: Cantón de Liberia, Parque Nacional Guanacaste, Cerro Cacao, 1100 m, (fr), *C. Chávez 578* (CR, MO); La Cruz de Abangares, 1400 m, (fr), *W. Haber & E. Bello 2861* (CR, MO); Cantón de Abangares, upper San Gerardo Valley, 1500 m, (fr), *W. Haber & W. Zuchowski 9534* (MO). **Puntarenas**: Reserva Biológica Monteverde, Arancibia de Miramar, 1600 m, (fr), *E. Bello 1359* (CR, MO); Monteverde, Pacific slope, 1500 m, (fr), *W. Haber & W. Zuchowski 9529* (CR, MO); Reserva Biológica Monteverde, Río Veracruz, 1300 m, (fl), *E. Bello 2776* (CR, MO); near the Reserve, 1520 m, (fl), *V. Dryer 1335* (MO); Monteverde, 1350 m, *N. Wheelwright 126d* (MO); Monteverde, 1350 m, (fr), *N. Wheelwright 4b* (MO); Monteverde, Pacific slope, 1450-1650 m, (fr), *W. Burger & R. Baker 9684* (MO); Monteverde, Pacific slope, 1500 m, (fr), *W. Haber & E. Bello 3683* (F, MO). **Limón**: Cantón de Limón, El Progreso, Cabecera del Río Cariei, Valle de La Estrella, 1400 m, (fl), *G. Herrera 2821* (MO). PANAMA. **Chiriquí**: Vicinity of Fortuna Dam, along trail to Río Hornito, 1100 m, (fr), *G. McPherson 11991* (MO); **Panamá**: Parque Nacional Altos de Campana, 1 km E of rangers camp, 800-900 m, (fr), *M. Correa & E. Montenegro 10793* (MO).

The leaves without domatia or with domatia in just the basal pair of lateral veins, along

with partially persistent tepals in the fruit distinguish this species from *C. triplinerve*, a species very close morphologically.

Cinnamomum pseudoglaziovii Lorea-Hernández, sp. nov. TYPE: Brazil. Santa Catarina: São Miguel, Porto União, 800 m, (fl), 9 December 1962, *R. Klein 3627* (holotype, MBM; isotypes, B, G, RB).

Arbores. Folia plerumque obovata vel oblanceolata, apice acuminato, triplinervia, infra plus minusve pubescentia trichomatibus undulatis vel crispis, adpressis; domatiis praesentibus ad axillas nonnullas venarum secundariarum, saepe praesentibus ad axillas infimas venarum tertiariarum, pagina foliari utrinque ad domatia subplana. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis carens. Flos tepalis extus glabratis aut plus minusve pubescentibus, pedicello glabro, hypanthio intus dense vel sparsim pubescente; tepalis in fructu partim persistentibus.

Trees (10) 15 - 20 m tall; twigs more or less angular, with low single ridges coming down from petiole bases, pubescent, hairs of two types, few rather straight 0.5 - 0.75 mm long, more or less appressed to erect, the majority wavy to curly 0.1 - 0.4 mm long, subappressed, persistent or soon deciduous; petiole (5.5) 8.5 - 14 mm long, (0.5) 0.8 - 1.2 (1.5) mm wide, pubescent when young, hairs as on twigs, soon glabrescent; leaf blades (3.5) 6.5 - 10.5 (13) cm long, (1) 2 - 4 (5) cm wide, obovate to oblanceolate, sometimes elliptic, apex acuminate, base acute to short attenuate, pubescent above when young, soon glabrescent, hairs as on twigs, straight ones rather

appressed and apparently restricted to veins, pubescent below, hairs as on upper surface but denser, lasting longer at least on some parts of foliar surface, triplinerved, midvein slightly sunken above, usually glabrous in old leaves, strongly raised below, pubescent or glabrescent, hairs as on twigs, stright hairs rather appressed, secondary veins 3 - 4 (5) pairs, lowest pair very conspicuous, marked to slightly sunken above, raised and thick below, pubescent or glabrescent, other pairs marked above and raised below, tertiary veins flat above, slightly raised below, primary domatia present, one or two upper pairs present besides the lowest pair, hairy, secondary domatia present, though not always conspicuous; inflorescences (5) 7 - 12 (16) cm long, axillary to foliose deciduous bracts or to leaves, cymose-paniculate, peduncle (2) 3 - 6 (9.5) cm long, pubescent, rachis pubescent to glabrescent, flower pedicel (2.5) 4 - 6.5 (7.5) mm long, glabrous; flowers greenish yellow, tepals 2 -2.8 mm long, 1.4 - 1.9 mm wide, ovate or elliptic, glabrous outside, sometimes sparsely pubescent, sericeous inside, stamens of whorls I & II 1.5 - 2.1 mm long, filaments sericeous ad and abaxially, sometimes glabrescent abaxially, anthers 0.8 - 1.1 mm long, glabrous ad and abaxially, sporangia four, in two pairs introrse, stamens of whorl III 1.8 - 2.3 mm long, densely sericeous adaxially, sericeous abaxially, anthers 0.7 - 1 mm long, sericeous adaxially, glabrous abaxially, sporangia four, in two pairs, upper ones latrorse, lower ones extrorse-latrorse, glands 0.6 mm long, above filament base, ovate-cordate, sericeous adaxially, glabrous abaxially, staminode 1.1 - 1.5 mm long, pedicel sericeous adaxially, mainly on upper half, sericeous abaxially, head 0.8 - 1 mm long, cordate-acuminate in outline, glabrous adaxially, sericeous abaxially, hypanthium 0.7 - 1.2 mm deep, glabrous outside, sometimes sparsely pubescent, sericeous inside or glabrescent, pistil 2.3 - 3.2 mm long, glabrous, ovary 1 - 1.4 mm long, 0.8 - 1.3 mm wide; fruit 12 - 16 mm long, 9 - 12 mm wide, cupule 3.5 - 8.5 mm long, 5.3 -

7.5 mm wide, pedicel 3 - 5.5 mm long, 0.9 - 1.2 mm wide, tepals usually deciduous for the most part, leaving just the base at the hypanthium rim, rarely deciduous as one piece.

Flowers present from September through December; ripe fruits in March. This species grows in *Araucaria* forests, but it has been recorded (undoubtly by mistake) also in Varzea forest, at an altitude between 200 and 1000 m. This species is rather common in the forests of southeastern Brazil, from São Paulo to Rio Grande do Sul.

Paratypes. BRAZIL. **Paraná**: Rio Negro, Doce Grande, (fl), *G. Hatschbach 3644* (MBM, RB); Iratí, March 1916, *P. Dusén s/n* (S); Ponta Grossa, 22 September 1911, *P. Dusén s/n* (S); Morretes, (fr), *P. Dusén 4460* (S). **Rio Grande do Sul**: São Francisco de Paula, Faz. Englert, (fl), *B. Rambo 54612* (RB). **Santa Catarina**: Florianópolis, Morro do Ribeirão, 400 m, (fl), *R. Klein 6921* (RB); Florianópolis, Morro do Ribeirão, 300 m, (fr), *R. Klein 8208* (RB); Florianópolis, Saco Grande, 200 m, (fl), *R. Klein 6897* (RB); Florianópolis, Morro Costa da Lagoa, 350 m, (fl), *R. Klein 7970* (RB); Ibirama, Horto Florestal I.N.P., 350 m, (fr), *R. Klein 1924* (B, G, RB, SP); Ibirama, Horto Florestal I.N.P., 350 m, (fr), *R. Klein 2610* (RB, SP); Ibirama, Horto Florestal I.N.P., 250 m, (fr), *R. Klein 1882* (RB); Imaruí, Rio Novo, Aguas Mornas, 500 m, (fl), *R. Klein 10538* (MBM, RB); Lajes, Encruzilhada, 900 m, (fl), *R. Klein 3195* (RB, SP); Papanduva, Serra do Espigão, 1000 m, (fl), *R. Klein 3990* (RB, SP); Porto União, Pôço Preto, 750 m, (fl), *R. Klein 3738* (RB); Rio do Sul, Matador, 350 m, *Reitz & Klein 7574* (RB); Sabiá, Vidal Ramos, 750 m, (fl), *R. Klein 2265* (RB, SP); **São Paulo**: São Paulo, Serra da Cantareira, *J. Baitello 369* (SPSF); São Paulo, Serra da Cantareira, (fl), 21 October 1979, *J.*

Baitello & O. Aguiar s/n (SPSF); São Paulo, Serra da Cantareira, (fl), 1 October 1982, *J. Baitello & O. Aguiar s/n* (SPSF); São Paulo, Serra da Cantareira, (fr), 2 December 1982, *J. Baitello & O. Aguiar s/n* (SPSF); São Paulo, Serra da Cantareira, (fl), *J. Baitello 233* (FCME, SPSF); São Paulo, Serra da Cantareira, (fl, fr), *A. Rodrigues 4* (FCME, IAN, SPSF); São Paulo, Serra da Cantareira, (fl), *K. Kubitzki 79-273* (NY); São Paulo, Serra da Cantareira, (fr), 30 January 1989, *O. Aguiar 300* (FCME, SPSF); São Paulo, Serra da Cantareira, (fr), 9 January 1969, *A. Rodrigues s/n* (SPSF); São Paulo, Serra da Cantareira, (fr), *J. Pastore 238* (FCME, MO, SPSF); Parque Estadual "Carlos Botelho", (fr), *P. de Moraes 790* (SPSF).

As the name of this species implies, similarity with *C. glaziovii* is so strong, that usually it was mistaken for this one. At first time, it seemed that differences in pubescence where just minor variations within populations of *C. glaziovii*; but the presence (in *C. pseudoglaziovii*) of wavy to curly hairs on lower leaf surface, along with the occurrence of more than one pair of primary domatia, secondary domatia usually distinct, and tepals partially persistent, supported the recognition of the new taxon. Besides, *C. pseudoglaziovii* has a geographic distribution that does not overlaps with *C. glaziovii*, which strengthen the decision of considering two distinct entities.

Cinnamomum quadrangulum Kostermans, Reinwardtia 6: 24. 1961.

Oreodaphne tetragona Meissner, Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1870: 137. 1870. Type. Brazil. Minas Gerais: Serra da Piedade, January-February 1866, *Warming*

693 (holotype, C!).

Phoebe tetragona (Meissner) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 184. 1889

Shrubs 0.5 - 1.5 (2) m tall; twigs sharply angular, winged, glabrous; petiole glabrous 0.5 - 1.25 (2) mm long, 1.1 - 1.7 mm wide; leaf blades (1.5) 2.5 - 5.5 (7.5) cm long, (1) 1.5 - 3 (4.5) cm wide, ovate, elliptic, or narrowly elliptic, apex obtuse or rounded, less acute, base cordate, chartaceo-coriaceous, pinnately veined or triplinerved, midvein shallowly marked above, raised below, glabrous, secondary veins slightly raised below, glabrous, tertiary veins inconspicuous on both surfaces, domatia absent; inflorescence (4) 7.5 - 14 (16) cm long, axillary to leaves, cymose-paniculate, with small foliose bracts in most of the main branching nodes, peduncle (1) 3 - 6 cm long, all axes glabrous, flower pedicels 3 - 8.5 (10) mm long, ; flower narrowly campanulate or urceolate, pale greenish yellow, tepals 1.8 - 2.2 mm long, 1.2 - 1.8 mm wide, ovate or elliptic, glabrous outside, sericeous inside, stamens of whorls I & II mm 1.2 - 1.7 mm long, filaments glabrous to sparsely pubescent adaxially and abaxially, anthers 0.7 - 1.0 mm long, glabrous, sporangia four, stamens of whorl III 1.4 - 1.7 mm long, filaments densely sericeous adaxially, glabrous or sparsely sericeous on the base abaxially, anthers 0.5 - 0.8 mm long, sericeous mainly on the lower half adaxially, sericeous on connective base abaxially, sporangia two, extrorse, less often four, then the lower ones twice as big or bigger than upper ones, glands 0.4 - 0.5 mm long, at filament base or slightly above it, sericeous adaxially, staminodes 0.7 - 0.9 mm long, filament sericeous on the margins and adaxially, sparsely sericeous abaxially, head 0.5 - 0.6 mm long, triangular, base slightly cordate, sericeous at the base adaxially, glabrous abaxially, pistil 1.5 - 2.0 mm long, ovary 0.8 - 1.1 mm long, 0.6 - 0.9 mm wide; fruit 10.0 15.5 mm long, 6.3 - 7.5 mm

Figure 13. Flowering branchlet of *C. quadrangulum*.

wide, ellipsoid, cupule 3 - 4.4 mm long, 3.2 - 4 mm wide, pedicel 2.0 - 5.5 mm long, 0.9 - 1.2 mm wide, tepals wholly persistent, upper part usually marcescent.

Flowers in January through May. Fruits April to June. Between 750 and 1850 m altitude, in rocky areas with iron ores. Vegetation type: campo cerrado, campo aberto, canga, campo rupestre. Although the species seems to be common, it is restricted to a rather small region in the area near Belo Horizonte (Minas Gerais) in Brazil.

General appearance of *C. quadrangulum* resembles *C. amplexicaule* from Mexico. The combination, however, of sharp angular twigs, almost sessile leaves with cordate bases, along with stamens of whorl III with a tendency to reduced or aborted upper sporangia, distinguish the former species from the latter one. The large disjunction itself, however, does not rule out necessarily the possibility of some relationship between the two species; as the cladistic analysis of relationships among the species suggests.

Specimens examined. BRAZIL. **Minas Gerais**. In monte serra da Piedade, *E. Warming 693* (C); Retiro das pedras, aprox. 3 km ao S de Belo Horizonte, *F. Lorea 5585* (FCME); Serra da Piedade, aprox. 6-7 km ao NE de Belo Horizonte, *F. Lorea 5589* (FCME); Belo Horizonte, Serra do Curral, *M. Magalhaes 1467* (MG); Entre Congonhas e Belo Horizonte km. 386, *E. Pereira & Pabst 2408* (MG, RB (3 sheets)); Belo Horizonte, BR 3, a 15 km de Belo Horizonte, *L. Roth 1724* (RB); Serra da Piedade, *E. Pereira & Pabst 3537* (RB); Near BR-31, ca. 35 km E of Belo Horizonte, in upper shrub-covered slopes of Serra da Piedade, *H.S. Irwin et al. 30400* (MO, ENCB); Belo Horizonte, Serra do Taquaril, *M. Barreto 7465* (F); without precise locality,

A. Glaziou 18435 (BR, C, F); Espigão do Lago dos Ingleses, *A. P. Duarte 10839* (RB); Belo Horizonte, antes da entrada para Ouro Preto, *P. S. Braga 2293* (RB, MO); Itabirito, 40km SE de Belo Horizonte., *J. M. Pires 57929* (MO); Belo Horizonte, Serra do Taquaril, *M. Barreto 7466* (F); Belo Horizonte, *L. Damazio 48696* (RB).

Cinnamomum rubrinervium Lorea-Hernández, sp. nov. TYPE: Brazil. Minas Gereais: Pedra Azul, divisa da Bahia, (fl), 21 September 1965, *A. Duarte 9295* (holotype, RB; isotype, MO).

Frutices aut arbusculae. Folia elliptica vel anguste elliptica, apice acuminato aut acutato, triplinervia vel subtriplinervia, infra dense pubescentia, pagina occulta trichomatibus crispis, adpressis vel patulis, venas usque ordinem quartum trichomatibus atrorubris tectum; domatiis carens (aut inconspicuis?). Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis nonnunquam praesentibus, satis deciduis. Flos tepalis extus glabratis, pedicello glabro, hypanthio intus pubescente vel glabrescente; fructus non cognitus.

Trees 3 - 5 m, or shrubs 1 - 3 m tall; twigs densely pubescent, hairs curly, mostly golden yellow, bands or strips of red hairs present too, persistent; petiole (4) 6 - 11 mm long, (0.5) 1 - 1.5 mm wide, densely pubescent, hairs as on twigs; leaf (2) 5.5 - 10 (12.5) cm long, (1) 2 - 3.5 (4.5) blade elliptic, narrowly elliptic or few ovate, apex acuminate or acute, base obtuse to acute or short attenuate, pubescent above when young, glabrous with age, densely pubescent below, leaf surface concealed, hairs curly, pale yellow, triplinerved or subtriplinerved, midvein sunken

above, pubescent to glabrous, raised below, pubescent, hairs mostly dark red, secondary veins (3) 4 - 5 pairs, lowest pair rather sunken above, raised below, other pairs slightly marked above, raised below, all covered with abundant red hairs, tertiary veins inconspicuous above, distinct but raised below, covered with abundant red hairs, domatia not present (not evident ?); inflorescence (3) 4.5 - 8.5 (11) cm long, axillary to leaves, sometimes to foliose bracts soon deciduous, toward twigs tips, foliose bracts sometimes present at main branchings, cymose-paniculate, peduncle (0.2) 0.5 - 3 (5) cm long, sparsely pubescent, rachis sparsely pubescent to glabrescent, flower pedicel (1.5) 2 - 3 (4) mm long, glabrous; flower narrowly campanulate, whitish, yellowish or greenish, tepals 2 - 2.7 mm long, 1.3 - 1.7 mm wide, ovate or elliptic, glabrous outside, sericeous inside, outer ones sometimes glabrescent toward their margins, red hairs present, stamens of whorls I & II 1.5 - 1.9 mm long, filament glabrous ad and abaxially, sometimes sparsely sericeous at base on both surfaces, anthers 0. 8 - 1.1 mm long, glabrous, sporangia four, stamens of whorl III 1.5 - 1.9 mm long, densely sericeous ad and abaxially, sometimes sparsely so abaxially, red hairs present, anthers 0.6 - 0.9 mm long, densely sericeous adaxially, rarely glabrescent, red hairs present, glabrous abaxially, sporangia two, rarely the two upper ones present, then small and connected with the lower ones, glands ca. 0.5 mm long, at or just above filament base, sericeous adaxially, staminode 0.9 - 1.2 mm long, filament densely long sericeous ad and abaxially, red hairs present, head 0.5 - 0.7 mm long, cordate-triangular in outline, sericeous adaxially at the base, abaxially along median section, hypanthium ca. 0.5 mm deep, glabrous outside, sericeous inside, red hairs usually present, sometimes pubescence patchy or in strips, pistil 1.8 - 2.2 mm long, glabrous, ovary 0.8 - 1.1 mm long, 0.8 - 1 mm wide; fruit not known, tepals partially (?) persistent.

Flowers present from August to November. Vegetation type: campo, campo rupestre, cerrado. Altitude 1000 - 1100 m. Growing in white sand soils. So far only known from a small area in around the border of Minas Gerais and Bahia states in Brazil.

Presence of red hairs on vegetative organs, besides their common occurence on the inner parts of flowers, is not a particularity of *C. rubrinervium* alone. They are seen from time to time on the edge of cataphyls in shoot buds, axillary buds, along stems, or also on veins on the leaves of several species. However, they never get to the point found in the leaves and stems of this species, where consistently they are abundant and visible with a hand lens (or to the naked eye). It is also separate from its closest morphological relative (*C. sellowianum*), by the absence of domatia, leaves never obovate or oblanceolate, and tepals (that seem to be) partially persistent.

Paratypes. BRAZIL. **Bahia**: Candido Sales, along highway BR-116, (fl), *G. Hatschbach 50030* (FCME, MBM, MO); Morro do Chapéu, (fl), *E. Pereira 10008* (HB); Rodovia BR-4 divisa dos Estados de Minas Gerais e Bahia, (fl), *R. Belém 1635* (IAN, NY, UB); Serra de Agua de Rega, ca. 23 km N of Seabra, 1000 m, (fl), *Irwin et al. 30868* (ENCB, MG, MO, NY). **Minas Gerais**: Jequitinhonha, Serra de Areia, ca. 47 km S of Pedra Azul, 1100 m, (fl), *R. Harley et al. 25261* (MO, SP); km 200 on road between Diamantina and Virgem da Lapa, (young fr), *A. Duarte s/n* (MO); Pedra Azul, para divisa da Bahia, (fl), *A. Duarte 10538* (MO, RB); Serra Sapucaia, 1000 m, (fl), *M. Magalhães 17282* (RB); Divisopolis, between Divisopolis and Joaima, (fl), *M. Magalhães s/n* (RB).

The *Irwin et al. 30868* collection is suspected to be conspecific with *C. rubrinervium*, but

the typical red hairs on veins are not as abundant as in the rest of the specimens referred to this new taxon. For the rather abundant spreading hairs on lower leaf surface, its morphology resembles that of *C. sellowianum*, yet the distribution and habitat where this species grows are totally different to the place the *Irwin et al. 30868* collection comes from. Therefore, I considered it to be related to this new species, and I included it in the additional material studied (paratype section).

Cinnamomum salicifolium (Nees) Kostermans, Reinwardtia 6: 23. 1961.

Phoebe salicifolia Nees, Linnaea 21: 488. 1848. Type. Mexico. Hidalgo: Huasca, near Regla, *Ehrenberg 875* (holotype B, n.v.; isotype, F!).

Persea salicifolia (Nees) Hemsley, Biol. Centr. Amer. III. 72. 1882.

Trees (3) 4 - 8 m, or shrubs 1 - 3 (4) m tall; twigs appressed pubescent, hairs 0.2 - 0.5 mm long, straight, few times slightly spreading far from branch surface; petiole (2.5) 4.0 - 7.5 (11.0) mm long, appressed pubescent to velutinous; leaf blade (2.0) 5.0 - 9.0 (12.0) cm long, and (1.0) 2.0 - 3.0 (4.5) cm wide, lanceolate to ovate, few times elliptic, apex acute to long acuminate, base obtuse to acute, triplinerved, subtriplinerved or, sometimes pinnately veined, with (3) 4 - 6 (7) pairs of secondary veins, upper surface appressed pubescent to glabrescent, hairs straight or slightly wavy, lower surface sparsely to densely appressed pubescent, often glaucous, usually with dark spots, likely produced by some parasite fungus, secondary veins appressed pubescent or glabrescent; primary domatia present in several axils of secondary veins, secondary domatia

absent; inflorescence 2.5 - 7.0 (9.5) cm long, axillary to leaves or to small deciduous bracts, cymose-paniculate, conspicuosly villous to glabrescent, flower pedicel (3.0) 4.5 - 7.5 (9.0) mm long, sparsely villous or glabrous; flowers 2.2 - 2.7 mm long, urceolate, greenish yellow, tepals 1.6 - 2.4 mm long, and 1.5 - 2.1 mm wide, ovate to widely ovate, sparsely villous to glabrous outside, sericeous inside, stamens of whorls I & II 1.1 - 1.9 mm long, their filaments villous or glabrous adaxially, villous abaxially, anthers glabrous except on connective base abaxially, stamens of whorl III 1.2 - 1.8 mm long, their filaments densely sericeous abaxially on the base, densely to sparsely sericeous adaxially, anthers glabrous except on connective and base of lower sporangia adaxially, sporangia four in all stamens, glands ca. 0.5 mm long, elliptic or rounded, staminodes 0.7 - 1.3 mm long, their filaments densely sericeous, apex dense to sparsely sericeous abaxially, hypanthium 0.4 - 0.5 mm deep, sparsely villous to glabrous outside, sericeous inside, sometimes only partially pubescent or almost glabrous, reddish hairs usually present inside, ovary and style glabrous; fruit 9.5 - 14.0 mm long, and 9.0 - 11.5 mm wide, rounded or ellipsoid, seated on the persistent tepals, pedicel turbinate, reddish.

C. salicifolium is a common species in the inland slopes in central eastern Sierra Madre in Mexico, in places with limestone outcrops where oak and pine forests grow. Sometimes it is found in wetter sites, like those with oak-pine mixed deciduous forest. It is known from places between 1000 - 1900 m of altitude. Flowers are produced from March to June, and mature fruits from August to November.

Type material available of *C. salicifolium* for study was scarce and fragmentary. However, even in the fragment filed at F, the typical appressed sericeous hairs on the leaf

surface, along with the hypanthium sericeous in its interior are unmistakeable. Furthermore, the characteristic fungal dark spots on the leaf undersurfaces can also be seen. No other species in the region has these spots, apparently a case of unispecific parasitism, and although not properly a feature of the plant itself, they can be used as a character for identification. Variation in *C. salicifolium* is found mainly on flower pubescence. Type material has tepals glabrous outside and hypanthium sericeous inside, but in the material now at hand there are specimens with inner tepals or the whole perianth more or less pubescent outside and hypanthia less pubescent inside in different degree, yet all of them have appressed sericeous pubescence on lower leaf surface and dark spots too.

Specimens examined. MEXICO. **Hidalgo**. Huasca, near Regla, *Ehrenberg 875* (F, A); Jacala, *V. H. Chase 7311* (MO, F); Zimapán, Los Nogales, 30 km al NE de Zimapán, *R. Hernández & I. Hernández 6541* (MO); Zimapán, La Majada, 20-25 km al NE de Zimapán, *R. Hernández & I. Hernández 6533* (ENCB, MO); Zimapán, Maguey Verde, 25km al NE de Zimapán, *R. Hernández 3736* (MO). **Querétaro**. Landa, 2km al SE de El Rincón, *H. Rubio 1854* (IEB); Landa, 1.5km al NE de El Rincón, *H. Rubio 2320* (IEB); Landa, Puerto del Soyatal, aprox. 5 km al N de Acatitlán de Zaragoza, *E. González 731* (IEB); Jalpan, 5-6km al S de La Parada, *B. Servín 300* (IEB); Landa, 2km al NE de El Sabinito, *H. Rubio 1611* (IEB); Landa, 1.5 km al SE de La Yesca, *H. Rubio 995* (IEB); Landa, El Bordo, 2km al SE de El Sabinito, *H. Rubio 621* (IEB); Pinal de Amoles, Al W de La Cuesta de Huazmazontla, *E. Carranza 2157* (IEB); Landa, 2km al NE de El Rincón de San José, *H. Rubio 1643* (IEB); Landa, 2km al SE de El Rincón de San José, *H. Rubio 1930* (IEB); Landa, El Sótano Colorado, 1km al NW de La

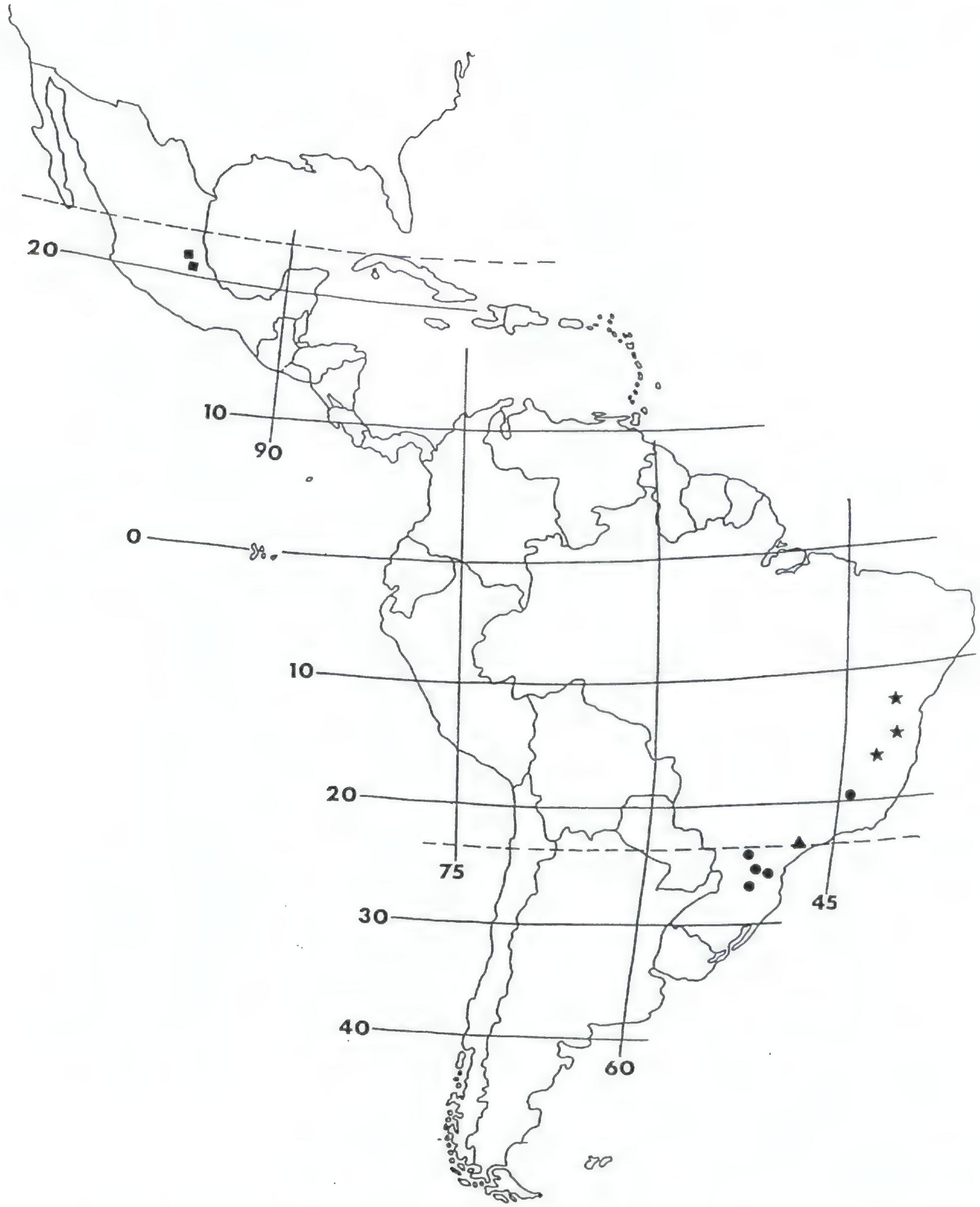


Figure 15. Known distribution of (★) *C. rubrinervium*, (■) *C. salicifolium*, (●) *C. sellowianum*, (▲) *C. stenophyllum*, and (○) *C. subsessile*.

Florida, *H. Rubio 16* (IEB); Landa, Puerto del Arrastradero, aprox. 6km al NE de Acatitlán de Zaragoza, *E. González 1139* (IEB); Jalpan, Aprox. 2km al ENE de Guayabas, *E. Carranza 1798* (IEB); Jalpan, Aprox. 2km al S de Soyalpica, *E. Carranza 541* (IEB); Cerca de Huazmazontla, 13 km al NE de Pinal de Amoles, sobre la carretera a Jalpan., *J. Rzedowski 48406* (IEB); Landa, 2km al SE de El Sabinito, *H. Rubio 516* (IEB); Landa, Puerto Verde, aprox. 5 km al SE de El Madroño, *E. González 492* (IEB); Landa, Puerto Malpaís aprox. km 227 carretera San Juan del Río-Xilitla., *E. Carranza 495* (IEB (2 dups)); Jalpan, 5km aprox. al SW de La Parada, camino a Soyalpica, *E. Carranza 1212* (IEB); Jalpan, Aprox. 3 km al S de La Parada, *E. Carranza 817* (IEB); Landa, Cerca de Tres Lagunas, *J. Rzedowski 46712* (IEB); Landa, Puerto Malpaís, carretera Jalpan-Xilitla, *F. Lorea 5550* (FCME (5 dups)).

Cinnamomum sellowianum (Nees et Martius) Kostermans, Reinwardtia 6: 23. 1961.

Persea sellowiana Nees et Martius, Linnaea 8: 50. 1833. Type. Brazil. Without precise locality, *Sellow 4783* (holotype, B, n.v; isotype, K!).

Phoebe sellowiana (Nees et Martius) Meissner, in DC. Prodr. 15: 30.1864.

Trees 5 - 10 m, or shrubs (?) up to 6 m tall; twigs densely pubescent, surface concealed, hairs curly, persistent; petiole (2) 6 - 10.5 (14) mm long, (0.5) 1 - 1.5 mm wide, densely pubescent, hairs as on twigs; leaf blades (2.5) 5 - 10 (12.5) cm long, (1) 2 - 3.5 (4.5) cm wide, elliptic to oblanceolate, sometimes narrowly elliptic, apex acute to long acuminate, often cuspidate, base acute to acuminate, pubescent above when young, soon glabrous, densely

pubescent below, leaf surface concealed, hairs curly, persistent, triplinerved, sometimes subtriplinerved or trinerved, midvein marked above, pubescent to glabrescent, raised below, densely pubescent, sometimes glabrescent with age, secondary veins 3 -5 pairs, slightly marked above, glabrescent or glabrous, raised below, densely pubescent, tertiary veins rather inconspicuous above, slightly raised below, pubescent, primary domatia present, but frequently not distinct, secondary domatia present, usually not distinct; inflorescence (2) 3 - 11 cm long, axillary to leaves, solitary or several on very short axillary branches with deciduous bracts, cymose-paniculate, sometimes last two branchings congested, foliose bracts sometimes present at main branchings, peduncle absent or 0.2 - 4 cm long, pubescent to glabrescent, rachis sparsely pubescent to glabrous, flower pedicel (1.5) 2 - 3.5 (4.5) mm long, glabrous; flower urceolate to narrow campanulate, greenish, greenish white, greenish yellow, tepals 2.1 - 2.9 mm long, 1.5 - 2.2 mm wide, ovate to widely ovate, sometimes elliptic, glabrous outside, sericeous inside, outer ones with upper half often glabrescent, red hairs present sometimes, stamens of whorls I & II 1.6 - 2.2 mm long, filaments sericeous ad and abaxially, sometimes saprsely so adaxially and glabrous abaxially, anthers 0.9 - 1.2 mm long, glabrous except for few hairs at base abaxially, and on connective base adaxially, sporangia four, stamens of whorl III 1.7 - 2.2 mm long, filaments sericeous ad and abaxially, red hairs sometimes present adaxially, anthers 0.7 - 1 mm long, sericeous adaxially, sparsely so at connective base abaxially, sporangia two, rather uncommon one or two upper ones present, then very small, glands 0.5 - 0.6 mm long, at base of filament, sericeous adaxially, staminode 1 - 1.5 mm long, filament sericeous ad and abaxially, head 0.6 - 0.9 mm long, narrow cordate, short sericeous at base adaxially, long sericeous abaxially, mostly at median section, hypanthium 0.4 - 0.5 mm deep, glabrous outside, sericeous

inside, sometimes (few) red hairs present, pistil 2 - 2.5 mm long, glabrous, ovary ca. 1 mm long, 0.7 - 1 mm wide; fruit 8 - 11 mm long, 6 - 8.5 mm wide, ellipsoid, cupule 2.5 - 7.5 mm long, 3.5 - 5.5 mm wide, pedicel absent or 1 - 6 mm long, 0.8 - 1.2 (2) mm wide, tepals persistent, acrescent.

Flowers are present from September to December, and March to April. Ripe fruits are found from November to February, and in May. Vegetation types where this species grows include capão, *Araucaria* forest, mata ciliar, cerrado, and campo rupestre; between (400) 750 - 1100 (1550) m of altitude. This species is rather common along the mountain ranges in southern Brazil, from São Paulo to Santa Catarina.

In his work about the plants collected by Sellow in Brazil, Nees (1833) does not give any collection number for the type collection of *Persea sellowiana*. Later, in his Systema Laurinarum, Nees (1836) cites *Sellow 4783* (flowers) and *Sellow 1559* (fruits) as the material studied at B. Only one duplicate of *Sellow 4783* was found at K in the loans requested for the present study. As the original description implies he studied only flowering material, thus I concluded *Sellow 4783* is the type collection of this species. There is, however, one duplicate of a Sellow collection (without number) at BR, apparently annotated by Nees, that is labeled as type material. Also a duplicate likely from same collection is at G. Both specimens however, look very alike to *Sellow 4783* but it is not possible to assure they belong to the same number.

For some time I thought *C. sellowianum* and *C. stenophyllum* were conspecific, but I prefer for the moment to treat them as different species. The reasons are the following: first, although there exist specimens of *C. sellowianum* with narrow leaves, these tend to present

subtriplinerved leaves, secondly, primary domatia are usually distinct in this species, while they are absent (or indistinct) in *C. stenophyllum*.

C. sellowianum has also some resemblance to *C. rubrinervium*, as has been commented above. The distinction of both taxa would be clearer if not for the existence of those collections discussed under *C. rubrinervium*, since distribution and habitat suggest they are really different. On the other hand, the collection *J. Mattos s/n* (SP) stands also in the middle, it does have on the veins abundant deep red hairs, but leaf shape (obovate), indument on lower leaf surface (with many spreading hairs), and distribution, suggest its affinity rather to *C. sellowianum*.

Specimens examined. BRASIL. **Minas Gerais**. Miguel Burmier, *L. Damazio 48697* (RB); without precise locality, *H. Berol s.n.* (); Serra do Gandarela, *A.P. Duarte 280* (RB); **Paraná**. Fazenda Cangueri, *H. G. Richter 26* (RB); Ponta Grossa, mun. Vila Velha, Parque Nacional de Vila Velha, *I. Rauscher s.n.* (); Ponta Grossa, Vilha Velha, *L. B. Smith, R. M. Klein & G. Hatschbach 14453* (P); Ponta Grossa, Passo do Pupo, *G. Hatschbach 18034* (F); São Matheus, *Gurgel 46363* (RB); Ponta Grossa, Vila Velha, *A. Gentry & E. Zardini 49868* (MO); Castro, Carambei, Rio S. João, *Reitz & Klein 17855* (F); S. Jose do Triunfo, Col. Palmeira, *G. Hatschbach 42178* (UB, MBM, C, MEXU); Palmeira, Col. Wietmarsum, *G. Hatschbach 13111* (NY); Balsa Nova, S. Luis do Puruna, *J. M. Silva & G. Hatschbach 28* (S); Estrada entre Ponta Grossa e Itarare, km. 203, *G. J. Sheperd & J. B. de Andrade 6141* (F); Serrinha, *P. Dusén 5167* (S); Jaguariahgua, *P. Dusén s.n.* (S (2 sheets)); Jaguariahgua, *P. Dusén 10508* (S); without precise locality, *P. Dusén s.n.* (S); Villa Velha, *G. Joussou 1217a* (S); Villa Velha, *P. Dusén s.n.* (S); without precise locality, *P. Macbride 27629* (F); Capão Grande, *P. Dusén 4340* (U); São

Matheus, *Gurgel 15184* (U); Gebiet des mittleren Ivahy, *G. Tessmann 6150* (U). **Santa Catarina**. Campo Novo, Mafra, *R. Klein 3903* (RB). **São Paulo**. Campo Grande Station (Via Ferrea São Paulo-Santos), *J. Mattos s.n.* (SPSF).

Cinnamomum stenophyllum (Meissner) Vattimo, Rodriguésia 31 (49): 8. 1979.

Persea stenophylla Meissner, in DC. Prodr. 15(1): 55. 1864. Type. Brazil. Mugy (?), *Riedel 1587* (holotype, LE, n.v.; isotypes, G!, K!).

Phoebe stenophylla (Meissner) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 190.1889.

Trees up to 6 m tall; twigs densely pubescent, hairs mostly curly, few rather straight and spreading, most persistent; petiole (2.5) 3 - 5.5 (7) mm long, 0.5 - 1.2 mm wide, pubescent, hairs as on twigs; leaf blade (1.5) 4.5 - 8 (9.5) cm long, (0.5) 1 - 1.5 (2) cm wide, narrowly elliptic, sometimes oblanceolate, sparsely pubescent when young, soon glabrous, densely pubescent below, laef surface concealed, hairs curly, few straight, sometimes white waxy under hair cover, pinnate nerved, midvein depressed above, sparsely pubescent or glabrous, raised below, pubescent, glabrescent with age, some straight spreading hairs present, red hairs sometimes present, secondary veins 6 - 9 (11) pairs, slightly marked above, glabrous or sparsely pubescent, raised below, densely pubescent, red hairs sometimes present, tertiary veins flat or slightly marked above, glabrous, slightly raised below, densely pubescent, primary domatia absent (or inconspicuous ?), sometimes axils glabrate, but maybe because of parasites that pupate there, secondary domatia absent; inflorescence (2) 4 - 7.5 (10.5) cm long, axillary to leaves, solitary or

clumped on very short axillary branches, then axillary to small deciduous bracts, cymose paniculate, usually last branchings congested, rarely with small foliose bracts, peduncle (0.5) 1 - 3 (4) cm long, pubescent, rachis glabrescent, flower pedicel (2) 2.5 - 3.5 (4.5) mm long, glabrescent or glabrous, sometimes glaucous; flower urceolate (?), tepals 2.2 - 3 mm long, 1.5 - 2.1 mm wide, ovate, glabrous outside, sericeous inside, outer ones sometimes glabrescent toward their margins, red hairs present sometimes, stamens of whorls I & II 1.6 - 1.9 mm long, filament sparsely sericeous at the base adaxially, glabrous abaxially, anthers ca. 1 mm long, glabrous ad and abaxially, sporangia four, stamens of whorl III 1.8 -2 mm long, filament long sericeous adaxially, red hairs present, sparsely sericeous along median section abaxially, anthers 0.7 - 0.9 mm long, sericeous adaxially, glabrous abaxially, sporangia two, sometimes one or two upper ones present, then tiny, glands ca. 0.5 mm long, at filament base, sericeous adaxially, staminode 1.2 - 1.4 mm long, filament long sericeous adaxially, sometimes only upper half, sparsely sericeous ababxially, head 0.6 - 1 mm long, triangular-cordate in outline, sericeous at base adaxially, (sparsely) long sericeous abaxially, hypanthium ca. 0.5 - 0.6 mm deep, glabrous outside, sericeous inside, pubescence sometimes in strips, red hairs present, pistil 2.2 - 3.1 mm long, glabrous, ovary 0.9 - 1.2 mm long, 0.7 - 1 mm wide; fruit 9 - 10 mm long, 6 - 7 mm wide, ellipsoid, cupule 2.5 - 4.5 mm long, 3.5 - 4.5 mm wide, pedicel 1.5 - 5 mm long, 0.7 - 1.2 mm wide, tepals persistent.

Flowers present in October - November. Fruits in December. Vegetation type: mata (no specific type mentioned), ca. 600 - 700 m altitude. Presently this species is known only from the nearby region to the city of São Paulo (São Paulo), Brazil.

As has been commented under *C. sellowianum*, *C. stenophyllum* is not sharply distinct from that species (except for the leaf pattern venation). However, the very localized distribution of *C. stenophyllum* towards the northern extreme of the range of *C. sellowianum* give support to the idea of two different taxa.

Specimens examined. BRAZIL. **São Paulo**. Guarulhos - S. Paulo, *B. Hettfleisch s.n.* (SP); Santo Amaro - S. Paulo, *E. Fischer s.n.* (SP); São Paulo, Nativa no Parque do Estado e Jardim Botanico, *F. C. Hoehne s.n.* (SP, K); São Paulo, Parque do Estado, *F. C. Hoehne 2340* (MO, SP); São Paulo, *F.C. Hoehne 28317* (NY, F, U). Without precise locality. *Riedel 1584* (K); *Riedel 1587* (G).

Cinnamomum subsessile (Meissner) Kostermans, Reinwardtia 6: 23. 1961.

Persea subsessilis Meissner, in DC. Prodr. 15(1): 54. 1864. Type. Peru?. San Carlos, *Mathews 1434* (holotype, K!).

Phoebe subsessilis (Meissner) Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 183.1889.

Tree or shrub (fide Mez); twigs ridged, ridges comming from petiole bases, glabrous; petioles 1.5-2 mm long, 2.5-3 mm wide, glabrous; leaf blades 17-25.5 cm long, 8-13 cm wide, elliptic or ovate, apex acute, base subcordate (amplexicaul), glabrous above and below, pinninerved, midvein slightly depressed above, glabrous, raised below, sparsely and inconspicuously pubescent, hairs straight and appressed, secondary veins 6-8 pairs, rather flat

above and below, tertiary veins flat above and below, domatia absent; inflorescence 17-26 cm long, axillary to leaves, cymose-paniculate, small foliose bracts sometimes present at main branchings, peduncle 10-14.5 cm long, glabrous, rachis glabrous, flower pedicel 6-7.5 mm long, glabrous; flowers urceolate, tepals 2-2.3 mm long, ca. 1.8 mm wide, wide ovate, glabrous outside, sericeous inside, stamens of whorls I & II ca. 1.5 mm long, filaments sparsely sericeous adaxially and abaxially on lower half, anthers ca. 0.8 mm long, glabrous ad and abaxially, sporangia four, introrse, stamens of whorl III ca. 1.5 mm long, filaments sparsely sericeous adaxially, sparsely sericeous at the base abaxially, anthers ca. 0.6 mm long, glabrous ad and abaxially, sporangia two, extrorse, glands ca. 0.5 mm long, at base of filament, ovate, sparsely sericeous adaxially at point of attachement, glabrous elsewhere, staminodes ca. 1 mm long, filament glabrous adaxially, except for the "fimbriate" sericeous margins, glabrous abaxially, head ca. 0.7 mm long, ovate acuminate in outline, glabrous ad and abaxially, hypanthium ca. 1.2 mm deep, glabrous outside and inside, pistil ca. 2.2 mm long, ovary ca. 1.5 mm long; fruit not known, but apparently tepals whole persistent.

There is no information about the type of habitat where this species grows, nor the time of the year when it was collected. The species is known only from the type collection.

The inclusion of this taxon in *Cinnamomum* is based on the presence of whorls of tepals about the same size, well developed staminodia, and distinct hypanthium. No other collection for this species could be found in the material studied, but the peculiar large subcordate amplexicaul leaves borne on thick ridged stems, separate it clearly from the closer morphological relatives: *C. formicarium*, and *C. hammelianum*.

Cinnamomum taubertianum (Mez et Schwacke) Kostermans, Reinwardtia 6: 24. 1961.

Phobe taubertiana Mez et Schwacke, Bot. Jahrb. Syst. 21: 427. 1896. Type. Brazil. Goiás: Serra dos Viadeiros, *Ule 3044* (holotype, M (?); isotype, P, n.v.).

Shrubs (?); twigs densely pubescent, surface concealed by hairs of two types, some 0.5 - 0.8 mm, erect or spreading, rather straight, others tightly matted, wavy to curly, rather appressed; petiole (1.5) 2.5 - 4.5 mm long, 1.2 - 1.8 mm wide, densely pubescent, hairs as on stems; leaf blades (2) 2.5 - 4 cm long, (1.5) 2 - 2.7 cm wide, ovate, apex obtuse to acutish, minute apiculate, base rounded, densely pubescent above when young, but surface still visible trough hairs, soon glabrescent or glabrous, densely pubescent below, surface concealed, hairs as on stems, persistent, triplinerved or few trinerved, midvein marked above, pubescent, raised below, concealed by hairs as on stems, secondary veins (2) 3 pairs, lowest pair marked above, raised below, densely pubescent, other secondaries slightly marked above, raised below but less aparent than first pair, concealed by dense pubescence, tertiary veins inconspicuous above, slightly raised below, concealed by hairs, domatia absent (inconspicuous ?); inflorescence 3.5 - 7.5 cm long, axillary to leaves, cymose-paniculate, often with small foliose bracts, peduncle 1.5 4.5 cm long, dense to sparsely pubescent, rachis sparsely pubescent, flower pedicel 2.5 - 3.5 (4) mm long, glabrous; flowers urceolate (?), tepals 2.8 - 3 mm long, 1.7 - 2.1 mm wide, ovate or elliptic, glabrous outside, sericeous inside, stamens of whorls I & II ca. 2.2 mm long, filaments sparsely pubescent ad and abaxially, anthers 1.1 mm long, glabrous, sporangia four, stamens of whorl III ca. 2.4 mm long, filaments densely sericeous adaxially, glabrescent abaxially, anthers 0.9 mm

long, sericeous adaxially, glabrous abaxially, sporangia two, sometimes the upper ones present, tiny and fused with the lower ones, glands 0.6 mm long, above filament base, sericeous adaxially, staminodes ca. 1.4 mm long, filaments sericeous adaxially, glabrous or glabrescent abaxially, head ca. 1 mm long triangular acuminate in outline, sericeous adaxially, mostly along median section, glabrous abaxially, hypanthium ca. 0.4 mm deep, glabrous ouside, pistil 2.2 - 2.4 mm long, glabrous, ovary ca. 1.1 mm long, 0.9 - 1.2 mm wide; fruit not known.

Flowers in August - September. Vegetation type: probably campo cerrado or campo rupestre. So far only known for a couple of collections in Goiás, central Brazil.

C. taubertianum is a very distinctive species and, in spite of being poorly known, is maintained here for the characters it presents. The whole lower surface of leaves concealed by hairs, coupled with the leaf shape and smooth (not conspicuous) appearance of most secondary and all tertiary veins, separate this species from *C. sellowianum*, a close morphological relative.

Typification of *C. taubertianum* is not solved. Ule and Sena collections are missing, and to date there is only one specimen available that is annotated as collected by Glaziou (*Glaziou 20455a*) near Ouro Preto, in Minas Gerais. However, a duplicate photographed at B (distributed as phototype) has Glaziou's number crossed out, and also a note written by Taubert saying that plant is a duplicate of the type then at his herbarium. The duplicate of *Glaziou 20455a* at P actually matches perfectly the original description for the species, so the name is still maintained.

Specimens examined. BRAZIL. **Minas Gerais**. Gamba, near Ouro Preto, *A. Glaziou 20455a* (P).

Cinnamomum tomentulosum Kostermans, Reinwardtia 6: 24. 1961.

Phoebe tomentosa Meissner, in DC. Prodr. 15: 30. 1864. Type. Brazil. Minas Gerais: Serra da Caraça, September 1824, *Riedel 522* (holotype, LE, n.v.; isotypes, NY!, US!).

Phoebe tomentosa var. *minor* Meissner, in DC. Prodr. 15: 30. 1864. Type. Brazil. Minas Gerais: Serra da Caraça, September 1824, *Riedel 522* pro parte, (holotype, LE, n.v.; isotype, NY!).

Persea erythropus var. *ovata* Meissner, in DC. Prodr. 15: 55. 1864. Type. Brazil. *Riedel 2462* (syntypes, BR!, G!).

Cinnamomum duartianum Vattimo, An. XV Congr. Soc. Bot. Brasil: 169. 1967. Type. Brazil. Minas Gerais: Serra da Catiara, 29 August 1950, *A. P. Duarte 3028* (holotype, BR!; isotypes, BR! (4 sheets)).

Trees 3 - 6 m, or shrubs 1 - 2 m tall; twigs densely pubescent, hairs 0.5 - 0.8 mm long, rather straight and erect, sometimes hairs wavy; petiole (4) 5 - 9.5 (14.5) mm long, 0.8 - 1.5 (2) mm wide, densely pubescent, hairs as on twigs; leaf blades (3.5) 6 - 11 (15) cm long, (1.5) 2.5 - 4.5 (5.5) cm wide, elliptic, apex acute to long acuminate, or apiculate, base obtuse or acute, densely but inconspicuously pubescent above when young, sparsely pubescent to glabrous with age, pubescent below, hairs more or less straight and erect, or spreading, rather persistent, leaf surface well visible trough hairs, triplinerved, few subtriplinerved, midvein marked above, densely pubescent, strongly raised below, pubescent, hairs as on leaf surface, secondary veins 3 - 5 (6) pairs, marked above, pubescent to glabrescent, raised and pubescent below, tertiary veins

slightly marked above or inconspicuous, slightly raised below, pubescent, primary domatia apparently present but inconspicuous (distinct tufts of hairs not present, but sunken areas sometimes evident); inflorescence (6.5) 7.5 - 12 (13.5) cm long, axillary to leaves, cymose paniculate, foliose bracts often present at main divisions, peduncle (2.5) 3 - 6 (8) cm long, pubescent, rachis pubescent or sparsely so, flower pedicel (2.5) 3 - 4 (5) mm long, glabrous; flower whitish, tepals 2.2 - 2.5 mm long, 1.1 - 1.9 mm wide, ovate to widely ovate, glabrous outside, densely sericeous inside, outer ones glabrous toward the upper margin, some red hairs present, stamens of whorl I & II 1.4 - 1.7 mm long, filaments sparsely pubescent ad and abaxially, sometimes glabrescent or only lower half pubescent, anthers ca. 1 mm long, glabrous ad and abaxially, or sparsely pubescent abaxially on connective, sporangia four, stamens of whorl III 1.4 - 2 mm long, filaments densely sericeo-tomentose ad and abaxially, few sparsely so abaxially, some red hairs present adaxially, anthers ca. 0.8 mm long, sericeo-tomentose adaxially on lower half, glabrous abaxially, sporangia two, but often one or two upper theace present but tiny or fused with the lower ones, glands 0.4 - 0.5 mm long, above filament base, short sericeous on adaxial surface at point of attachment, staminodes 0.9 - 1 mm long, filament densely sericeo-tomentose ad and abaxially, red hairs on adaxial surface, head 0.5 - 0.8 mm long, cordate triangular in outline, long sericeous on abaxial surface along median section and base, hypanthium 0.4 - 0.5 mm deep, glabrous outside, densely pubescent inside, red hairs present, sometimes abundant, pistil 1.9 - 2.2 mm long, glabrous, ovary 0.8 - 1 mm long, 0.8 - 1 mm wide; fruit 9 - 10 mm long, 6.5 - 7 mm wide, ellipsoid, cupule 3.5 - 4 mm long, 3.5 - 4 mm wide, pedicel 2 - 4 mm long, 1 - 1.2 mm wide, tepals partially persistent.

Flowers are produced in September, and fruits are found in November (young) and January. This species grows in the cerrado and forest patches intermixed with it; between an altitude of 1300 - 1400 m. The geographic distribution goes from around Belo Horizonte toward the northeastern part of Minas Gerais state, and adjacent Bahia in Brazil.

C. tomentulosum is variable on its vegetative morphology; size, shape, and pubescence of leaves. The gradation, however, does not have clear gaps between the several morphotypes and so, no seggregates are considered proper to create. *C. duartianum* is considered here a glabrous form of *C. tomentulosum*.

At some point, *C. tomentulosum* comes very close to some extremes of variation of the also variable *C. haussknechtii*. The best combination of characters to separate them includes hairs on lower leaf surface rather erect and abundant, leaf undersurface not glaucous, and leaf apex acute to long acuminate in the former species, while the latter one combines hairs on lower leaf surface usually spreading, leaf undersurface glaucous, and leaf apex acute to obtuse.

Specimens examined. BRASIL. **Bahia**. Morro do Chapéu, *E. Pereira 9943* (RB). **Minas Gerais**. Without precise locality, *Riedel 2462* (BR, G); Serra da Caraça, *Riedel 522* (US, NY); Estr. Diamantina-Curvelo, a 17 km de Diamantina, *N. L. Menezes et al. 22147* (MO, SP); 10 km SW of Diamantina, *H. S. Irwin et al. 22448* (MO, NY); Diamantina, *A. P. Duarte 9943* (MO); Diamantina, *A. P. Duarte 8930* (RB); Chapada de Pirapora, *E. P. Heringer & L. R. Guimarais 9817* (RB(2 dups), SP); Serra de Ouro Preto para Belo Horizonte, *A. P. Duarte 8626* (RB(2 dups)); Serra da Piedade, aprox. 6-7 km ao NE de Belo Horizonte, *F. Lorea 5590* (FCME).

Fifure 16. Known distribution of (★) *C. taubertianum*, (■) *C. tomentulosum*, (●) *C. tonduzii*, (▲) *C. uninervium*, (○) *C. velvetii*, and (⬡) *C. zapatae*.

Cinnamomum tonduzii (Mez) Kostermans, Reinwardtia 6: 24. 1961.

Phoebe tonduzii Mez, Bot. Jahrb. Syst. 30, Beibl. 67: 15. 1901. Type. Costa Rica. Copey, February, *Tonduz 11735* (holotype, B n.v.; isotypes, BM!, BR! (2 sheets), F!, NY!, P!, US!).

Trees 15 - 20 m tall; twigs ridged, one or two ridges coming down from petiole insertions, densely tomentose, surface concealed, hairs ca. 0.2 (0.3) mm long, curly, mostly appressed to spreading; petioles (10) 13.5 - 20 (25) mm long, 0.8 - 1.5 mm wide, dense tomentose, hairs as on twigs; leaf blades (5) 7 - 10 (12) cm long, 2.5 - 5 (7) cm wide, ovate or elliptic, apex acute to acuminate, base acute or obtuse, tomentose above when young, glabrous very soon, tomentose below, usually most surface soon glabrous, hairs curled, appressed, triplinerved, sometimes subtriplinerved, midvein slightly marked to flat above, glabrous, raised below, glabrous or glabrescent, secondary veins 4 - 5 pairs, flat above, raised or slightly raised below, tertiary veins flat above, almost flat below, primary domatia present, one or two pairs, secondary domatia often present in lowest pair of secondaries; inflorescence (4) 6 - 13 (16) cm long, axillary to leaves, cymose-paniculate, foliose bracts sometimes present, peduncle (1.5) 3 - 8.5 cm long, densely tomentose, rachis densely tomentose, flower pedicel 4 - 5.5 mm long, densely tomentose; flower narrow campanulate or urceolate, tepals 2.3 - 2.6 mm long, 1.6 - 1.9 mm wide, ovate, densely tomentose outside, sericeous inside, stamens of whorls I & II ca. 1.8 mm long, filaments sparsely sericeous adaxially, sericeous abaxially, anthers ca. 1 mm long, glabrous ad and abaxially, sometimes few hairs along connective adaxially, sporangia four, introrse, stamens of whorl III 1.8 - 2 mm long, filaments dense sericeous adaxially, red hairs

present sometimes, sericeous abaxially, particularly on lower half, anthers ca. 0.8 mm long, sericeous on lower half adaxially, elsewhere glabrous, sporangia four, upper ones latrorse, lower ones extrorse-latrorse, glands ca. 0.5 mm long, on lower third of filament, ovate, sericeous adaxially on point of attachment, glabrous elsewhere, staminodes ca. 1.3 mm long, filaments densely sericeous ad and abaxially, red hairs present, head 0.8 mm long, cordate in outline, acuminate, glabrous adaxially, sericeous abaxially, hypanthium 0.5 mm deep, densely tomentose outside, red sericeous inside, pistil 2.2 - 2.4 mm long, ovary ca. 1 mm long, 1 mm wide; fruit 11.5 - 18 mm long, 7 - 10 mm wide, cupule 5 - 8.5 mm long, 6.5 - 8 mm wide, sometimes narrowing gradually to a bottom ca. 1.5 mm wide, pedicel 1.5 - 3 mm long, 1.7 - 2.1 mm wide, or sometimes not distinct, tepals partially persistent.

Flowers are present in February and March, and fruits in July and September. No specific type of vegetation is mentioned on specimens labels, but given the altitudinal range where this species occurs (1600 - 2100 m), it is likely the habitat to be cloud forest. The species is restricted to southeastern Costa Rica and western Panama, and apparently is not common.

The presence of wavy to curly hairs on leaves, along with secondary domatia, and tepals partially persistent in fruit works well to separate this species from others in the area. Curly hairs and domatia suggest certain relationship to *C. zapatae*, but in the last species hairs tend to be persistent, and domatia are more abundant; besides this, tepals are persistent in the latter.

Specimens examined. COSTA RICA. **Puntarenas**. Cerro Quijada de Diablo near the border with Panama, *W. Burger et al. 12193* (F, MO); Buenos aires, Sabanas de Murur-Bisuk,

cabeceras del Río Ceibo, El Carmen, *A. Chacón 452* (MO); Monteverde community, Pacific slope, *W. Haber 10367* (MO); Monteverde, Pacific slope, moist forest patches and farms, *W. Haber 9851* (MO); Monteverde, *N. T. Wheelwright 103* (MO); Monteverde, Cordillera de Tilarán, Altos de Santa Elena, *E. Bello 4336* (MO(3 dups)); Cordillera de Tilarán. San Luis; Trapiche, Monteverde, *Z. Fuentes 676* (MO(2 dups)); Copey, *A. Tonduz 11735* (F (2 sheets), A, US, BR, P, NY(2 sheets), GH, G,). PANAMA. **Chiriquí**. Western slopes of Cerro Horqueta, *P.H. Allen s.n.* (G, MO).

Cinnamomum triplinerve (Ruiz & Pavón) Kostermans, Reinwardtia 6: 24. 1961.

Laurus triplinervis Ruiz & Pavón, Fl. Peruv. 4: t. 363. 1802. Type. Peru. Near Cuchero, *Ruiz & Pavón s/n* (syntypes: BM!, F! (2 sheets), MO!).

Phoebe peruviana Meissner, in DC. Prodr. 15(1): 32. 1864. Type. Peru. Near Cuchero, *Ruiz & Pavón s/n*. Illegitimate name.

Cinnamomum peruvianum (Meissner) Kostermans, Reinwardtia 10: 448. 1988.

Persea cinnamomifolia Humboldt, Bonpland & Kunth, Nov. Gen et Sp. 2: 160. 1817. Type. Colombia. Without precise locality, *Humbodt & Bonpland s/n* (syntype: F! (one leaf)).

Phoebe cinnamomifolia (Humboldt, Bonpland & Kunth) Nees, Linnaea 21: 488. 1848.

Cinnamomum cinnamomifolium (Humboldt, Bonpland & Kunth) Kostermans, Reinwardtia 6: 20. 1961.

Laurus elongata Vahl ex Nees, Syst. Laur. 116. 1836. Type. Lesser Antilles. Montserrat, *M. Vahl s. n.* (syntype, C!).

Phoebe elongata (Nees) Nees, Syst. Laur. 116. 1836.

Phoebe maynensis Nees, Syst. Laur. 118. 1836. Type. Peru. Loreto: near Yurimaguas and Maynas, *Poeppig 2305* (syntypes, BM!, F!, US!).

Phoebe peruviana var. *glabriflora* Meissner, in DC. Prodr. 15(1): 32. 1864. Nom. illeg.

Cinnamomum maynense (Nees) Kostermans, Reinwardtia 6: 22. 1961.

Phoebe cubensis Nees, Syst. Laur. 120. 1836. Type. Cuba. Without precise locality, *Poeppig s. n.* (holotype, B!; isotypes, B!, BR! (2 sheets)).

Phoebe valenzuelana A. Richard, in R. de la Sagra. Hist. fis. Cuba, Bot. 11: 185. 1850. Type. Cuba. Without precise locality, *R. de la Sagra s. n.* (holotype, P!).

Phoebe antillana var. *cubensis* Meissner, in DC. Prodr. 15(1): 31. 1864. Type. Cuba. La Habana, *R. de la Sagra 269* (syntype, NY!).

Phoebe granatensis Meissner, in DC. Prodr. 15(1): 32. 1864. Type.

Phoebe mexicana Meissner, in DC. Prodr. 15(1): 31. 1864. Type. Mexico. Veracruz: near Xalapa, *Galeotti 7026* (syntype: BR!), *Linden 20* (syntypes: BR!, F!, G! (2 sheets)).

Persea mexicana (Meissner) Hemsley, Biol. Centr. Amer. III. 72. 1882.

Cinnamomum mexicanum (Meissner) Kostermans, Reinwardtia 6: 22. 1961.

Phoebe poeppigii Meissner, in DC. Prodr. 15(1): 33. 1864.Type. Peru. Near Cuchero, *Poeppig 1311* (syntypes, BM!, F!, G! (2 sheets), NY!, W!).

Phoebe brasiliensis Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 198. 1889. Type. Brazil. Without precise locality, *Glaziou 11459* (syntype, C!), *Glaziou 12132* (syntypes, C!, F! (fragment), G!, NY!), *Glaziou 13153* (syntypes, B!, BR!, C!, G!).

Cinnamomum brasiliensis (Mez) Kostermans, Reinwardtia 6: 20. 1961.

Phoebe mexicana var. *bourgeauviana* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 214. 1889. Type. Mexico. Veracruz. Valley of Córdoba, *Bourgeau 2302* (syntypes: F!, P!).

Phoebe heterotepala Mez, Repert. Spec. Nov. Regni Veg. 3: 67. 1906. Type. Peru. Huamiles. Huánuco: at Monson, 2 August 1903, *Weberbauer 3487* (syntypes: F! (fragment), G!), *Weberbauer, 3496* (syntype: F! (fragment)).

Cinnamomum heterotepalum (Mez) Kostermans, Reinwardtia 6: 21. 1961.

Phoebe paraguariensis Hassler, Annuaire Conserv. Jard. Bot. Genève 21: 79. 1919. Type. Paraguay. Amambay: Santo Tomás, Sierra de Amambay, August , *Hassler 11305* (syntypes, A! (2 sheets), BM!, F!, G! (3 sheets), NY!).

Cinnamomum paraguariensis (Hassler) Kostermans, Reinwardtia 6: 22. 1961.

Ocotea flavescens Rusby, Descr. New Sp. S. Amer. Pl. 20. 1920. Type. Colombia. Magdalena: Sierra de Santa Marta, near Valparaíso?, *H. Smith 1762* (holotype, NY n.v.; isotypes, G!, GH!, MO!).

Phoebe pichisensis A.C. Smith, Bull. Torrey Bot. Club 58: 103. 1931. Type. Peru. Junín: km 3-10, on Pichis trail, 28 June 1929, *Killip & Smith 25430* (holotype, NY!; isotypes, F!, US!).

Cinnamomum pichisense (A.C. Smith) Kostermans, Reinwardtia 6: 23. 1961.

Phoebe johnstonii C.K. Allen, J. Arnold Arbor. 26: 433. 1945. Type. Panama. Canal Zone, 11 April 1945, *Johnston 697* (holotype: A!; isotypes: A!, US!).

Cinnamomum johnstonii (C.K. Allen) Kostermans, Reinwardtia 6: 21. 1961.

Cinnamomum australe Vattimo, Arch. Jard. Bot. Rio de Janeiro 17: 224. 1962. Type. Brazil. Santa Catarina: Ibirama, 20 September 1956, *Reitz & Klein 9082* (holotype, RB!; isotypes, B!, BR!, G!, NY!, US!).

Cinnamomum chana Vattimo, Arch. Jard. Bot. Rio de Janeiro 17: 223. 1962. Type. Brazil. Paraíba: Areia, vecinity of Escola de Agronomia do Nordeste, 15 October 1944, *J.M. Vasconcelos 124* (holotype, RB!; isotypes, RB!, SP!).

Cinnamomum xinguense Vattimo, Arch. Jard. Bot. Rio de Janeiro 17: 224. 1962. Type. Brazil. Pará: Xingu, between Vitoria and Ponte Nova, 7 August 1918, *Ducke s/n* (holotype, RB!).

Phoebe filamentosa C.K. Allen, Mem. New York Bot. Gard. 15: 69. 1966. Type. Venezuela. Mérida: along Río Onia, near Bolero, north of Mesa Bolívar, 23 May 1944, *J. Steyermark 56740* (holotype, F!; isotypes, F!, MO!, VEN!).

Cinnamomum portosecurianum Vattimo, Anais Congr. Soc. Bot. Brasil 15: 170. 1967. Type. Brazil. Bahia: Pôrto Seguro, November , *Duarte 8044* (holotype, RB!; isotype, RB!).

Phoebe pickelii Coe-Teixeira, Hoehnea 1: 87. 1971. Type. Brazil. São Paulo: Vecinity of São Paulo, Chácara dos Morrinhos, *B. Pickel 4422* (holotype, not found; isotype, SP!).

Cinnamomum pickelii (Coe-Teixeira) Kostermans, Reinwardtia 10: 448. 1988.

Phoebe fruticosa Lundell, Wrightia 5: 342. 1977. Type. Mexico. Chiapas: Mpo. Tuxtla Gutiérrez, steep slope at El Sumidero, 2 July 1965, *D. Breedlove 10671* (holotype, LL!; isotypes, DS!, ENCB!, MICH!, NY!).

Cinnamomum fruticosum (Lundell) Kostermans, Reinwardtia 10: 443. 1988.

Trees up to 25 m tall; twigs more or less pubescentes or glabrescent, hairs mostly spreading to appressed, straight to wavy, sparse with age; petioles 10 -15 (25) mm long; leaf blades (3.5) 6 - 13 (22) cm long, (1.5) 3 - 5.5 (9) cm wide, narrow elliptic, elliptic, or ovate, apex acute to acuminate, base acute to obtuse, glabrous above, usually pubescent below, but

Figure 17. Flowering branchlet of *C. triplinerve*.

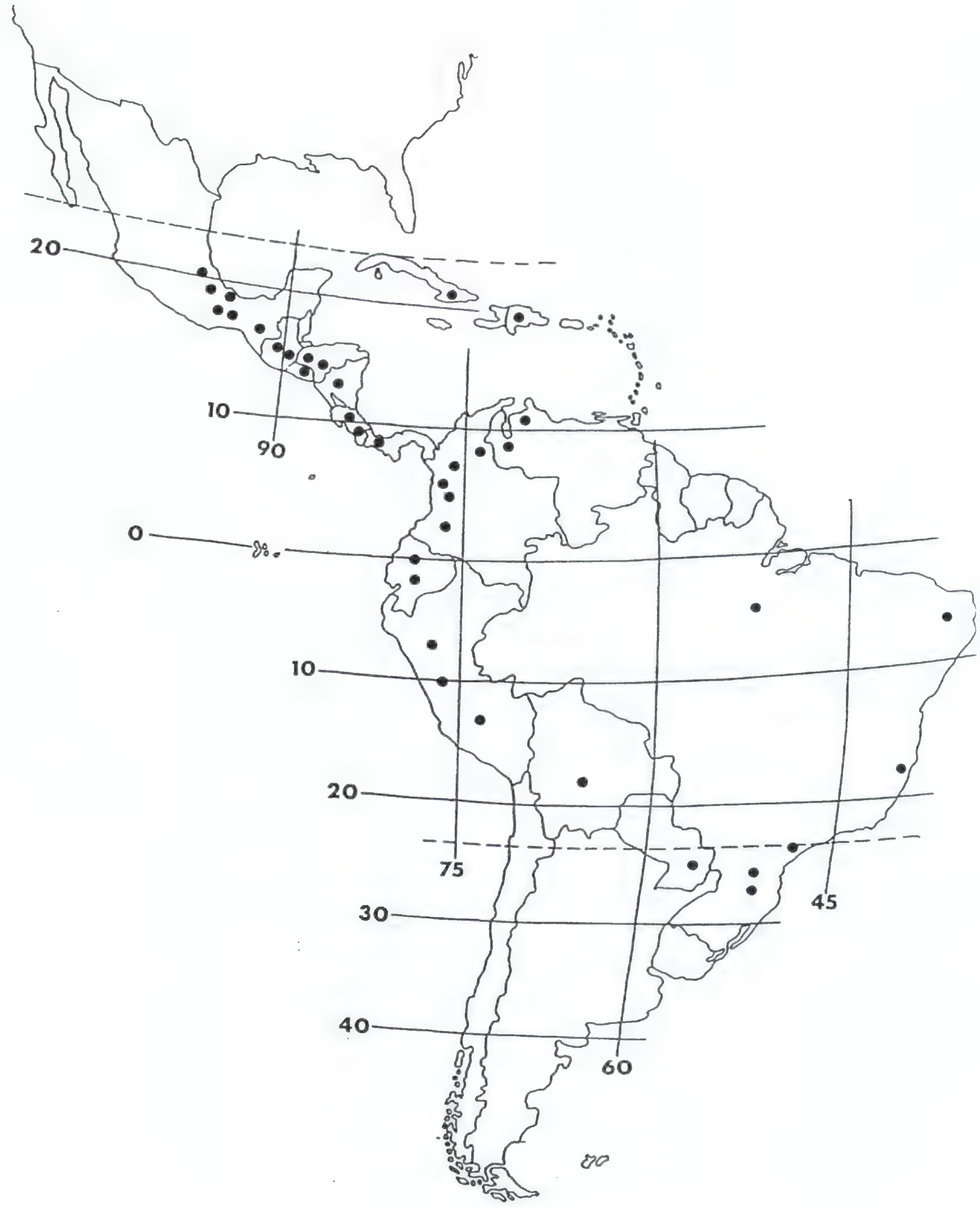


Figure 18. Known distribution of (●) *C. triplinerve*

sometimes inconspicuously so or glabrescent, triplinerved to subtriplinerved, midvein slightly sunken above, raised below, secondary veins rather flat above, slightly raised below, tertiary veins rather flat above and below, primary domatia in several pairs along midvein, rarely only basal pair present, secondary domatia, when present, just a few and not in all leaves; inflorescences (2) 5 - 15 cm long, single or clustered on short branches axillary to leaves, sometimes at the base of new shoots, peduncle, rachis, flower pedicel (2) 3 - 5 mm long, foliose bracts absent; flowers urceolate, greenish white, tepals 2 -2.5 mm long, ovate, usually pubescent outside, sometimes glabrous, sericeous inside, red hairs rarely present, stamens of whorls I & II 1.5 - 2 mm long, filaments usually sericeo-pilose ad and abaxially, anthers glabrous adaxially, glabrescent or sparsely sericeous abaxially, sporangia four, stamens of whorl III 1.5 - 2.5 mm long, filament usually densely sericeous adaxially, red hairs present, anthers glabrescent to sericeous adaxially, glabrous abaxially, sporangia four, upper ones latrorse, lower ones latrorse-extrorse, glands ca. 0.5 mm long, at base of filament or slightly above it, staminodes 0.8 - 1 mm long, filament, usually sericeous ad and abaxially, head 0.5 - 0.7 mm long, triangular to cordate acuminate in outline, hypanthium 0.5 - 0.8 mm deep, pubescent to glabrous outside, usually densely sericeous inside, red hairs usally present, pistil ca. 1.8 - 2.5 mm long, ovary 1 - 1.5 mm long; fruit ellipsoid, cupule, tepals mostly persistent.

C. triplinerve is, as circumscribed here, a very variable species. There are several groups identifiable on the basis of particular combinations of characters, but all of them have intermediate conditions that connect the groups in a way that is extremely difficult to draw the lines to recognize different taxa. Perhaps the only feature that keep together all the forms is the

papillose lower surface of the leaves.

On the other hand, the name applied here to this species may be no definitive. I did not see authentic material of *Laurus montana*, which is an older name than *Laurus triplinervis*. The former species was based on *Swartz 1513* collection, but the specimen(s) could not be found in the loans at hand. However, there is a Swartz collection at BM without number and no additional information which is annotated as *Laurs montana*, but clearly belongs to *C. triplinerve*. If it can be proved later that *L. montana* is conspecific with *C. triplinerve*, then the name will have to be changed to *Cinnamomum montanum* (Swartz) Berchtold & J. Presl.

Specimens with appressed hairs on twigs and lower leaf surface, leaves only with primary domatia, single inflorescenses, and pubescent tepals outside, match the types of *Phoebe heterotepala*, *P. johnstonii*, *P. mexicana* (in part *Linden 20*), *P. pichisensis*, and *P. poeppigii*. This morphotype is apparently the most abundant in the area of study. A slight variation to inflorescences clustered on short axillary twigs, a condition which is found over all the distribution range of the species, fits types of *P. mexicana* (*Linden 20*, in part) and *P. mexicana* var. *bourgeauviana*. Within these two groups there are still two more subgroups recognizable by the abundance and length of hairs on the lower leaf surface; one group has leaves conspicuously pubescent underneath, and is found here and there from southern Mexico to northern Venezuela, the second group, with leaves inconspicuously pubescent underneath is found throughout the species range distribution. So far, no name has been created for the pubescent variety.

Type of *Phoebe paraguariensis* (partially), and *Ocotea flavescens*, represent slight variations to the big group mentioned above, with hairs spreading to erect on twigs, and secondary domatia sometimes present respectively. Most of the flowers in type material of *P.*

paraguariensis have rather glabrous tepals outside, but there is a wide range of variation in this character among individuals across the study area.

Plants with hairs spreading to erect on twigs, leaves with hairs spreading to erect on lower surface, secondary domatia sometimes present, and tepals pubescent outside correspond to types of *Cinnamomum australe*, *Laurus triplinervis*, and *Phoebe brasiliensis*. A slight variation to leaves without secondary domatia is represented by the type of *Phoebe pickelii*.

Types of *Cinnamomum chana*, *Phoebe filamentosa*, and *P. fruticosa* represent specimens with hairs appressed to erect on twigs, leaves with appressed to spreading hairs on lower surface (very often glabrous with age), secondary domatia present, and flowers glabrous outside. The condition of leaves without secondary domatia in this group correspond to the types of *Cinnamomum xinguense* and *Phoebe maynensis*. An extreme of variation shown by plants with twigs and leaves (almost) glabrous, but with tepals (at least the inner ones) pubescent outside, is represented by the type of *Cinnamomum portosecurianum*.

Specimens examined (selected). BELIZE. **Cayo**. Opposite Vaca, *P. H. Gentle 2499* (MO). **Orange Walk**. From mile 50, Northern Highway to new river toll bridge, *J. D. Dwyer 12755* (MO(3 sheets), ENCB). **Stann Creek**. Middlesex, *P. H. Gentle 2941* (NY). **Toledo**. At base of hill beyond San Antonio, *P.H. Gentle 7553* (MO); Hope creek, *W.A. Schipp 281* (F); Hope Creek, *P. H. Gentle 7937* (MO, F). COLOMBIA. **Antioquia**. Betania, Vereda Los Picos, Finca Los Manzanos, *D. Sánchez et al. 1181* (MO); Hispania, 3.3 km de Hispania a la Vereda La Palmira, *R. Fonnegra et al. 2482* (MO); Cocorná, *H. Daniel 1628* (F); Cocorná, *H. Daniel 1359* (F); Amalfi, Valley of Rio Porce, 1-5 km SE of Puente Acacias (bridge over Rio Porce) towards

Amalfi, J.*M. MacDougal et al. 4063* (MO (7 dups)). **Bolívar**. San Martín de Loba, *H.M. Curran 1916* (F); Vía Carmen de Bolívar-Alto La Causona, *H. Cuadros 1051* (MO); Morales, cgto. Norosi, camino a Tiquisionuevo, *H. Cuadros 2150* (MO). **Caldas**. Victoria, El Llano, *W. Vargas 828* (MO); Filadelfia, 8-11km de La Felisa a Filadelfia, *J. Betancur et al. 2414* (MO). **Cauca**. Santander de Quilichao, Carretera entre Timba y Suárez, cerca al corregimiento del Salado, rivera del Río Cauca, *J. E. Ramos et al. 3606* (MO); Cerca a Mondomo, *S. Espinal T. & J.E. Ramos 2679* (MO), Highlands of Popayan, *Lehmann 9095* (F); El Tambo, *K. von Sneiden 1265* (S). **Cundinamarca**. Caqueza, quebrada Naranjal, 25 km de Caqueza a Guayabetal, cordillera oriental, vertiente oriental, *J. Betancur et al. 4143* (MO). **Huila**. La Plata, Hacienda La Limona., *G. Lozano et al. 4806* (ENCB, F). **Magdalena**. Santa Marta, Minca region., *Espina & Giacometto A1* (F); Santa Marta, *H. Smith 1762* (GH, G, MO,); Santa Marta, Sierra Nevada de Santa Marta, Minca, *S. Madriñan & A.C. Church 626* (MO). **Meta**. Carretera hacia Villavicencio, *J.M. Duque Jaramillo 3950* (VEN). **Nariño**. Mpo. Ricaurte, Reserva Natural La Planada, Cordillera Occidental, *W. Beltran 041* (MO). **Norte de Santander**. Ocaña, *L. Schlim 509* (BR,G(3sheets)). **Tolima**. El Guamo, carretera a Saldaña, *H. Garcia-Barriga 13490* (NY). **Valle**. Cordillera Occidental, filo de la Cordillera sobre Las Brisas, entre El Tabor y Alto de Mira., *J. Cuatrecasas 22431* (F); Cordillera Occidental, vertiente occidental, El Carmen, *J. Cuatrecasas 19709* (F); Along old highway between Cali and Buenaventura, 36km W of its turnoff from the new pavement (5km of village of Borrero Ayerbe), *T. Croat 38592* (MO); Cordillera Occidental, Vertiente Occidental, Carretera Vieja entre Cali y Buenaventura, *L. de Escobar et al. 2588* (F, MO); Río Frío, vereda La Trinidad, Finca El Porvenir, *A. Gentry 54058* (MO); Cali, Río Pance; Parque de la Salud, *P. Acevedo R. et al. 6763* (MO); Municipio de Cali,

margen izquierda del Río Pance, *I. Cabrera 3446* (MO).Without precise locality..*J. Triana 1017* (BM, NY);.*J. Triana 1589* (BM);.*J. Triana 1018* (BM);.*J. Triana 1016* (NY); *H. Murphy et al. 618* (MO); *Humboldt 3590* (G); *Humboldt s.n.* (G). BOLIVIA. **La Paz**. Along the Río Yalisa up river from where it crosses the Suapi turn off 4 km N of Coroico, *M. Lewis 37922* (MO (15 dups)). Without precise locality. *A. M. Bang 705* (C). BRAZIL. **Ceará**. Juaramiranga, Serra de Baturite, *A. Ducke 1613* (RB (2 sheets)); Serra de Baturite (Sitio Caridade), *J. Eugenio S.V. 564* (RB (2 sheets)); Pacatuba, Pitaguari, *J. Elias de Paula et al. 1258* (UB); Pacatuba, Serra no sitio do Pitaguari, *J. Elias de Paula et al. 1250* (NY). **Pará**. Guaramiranga, *A. Ducke 1613* (MG); Altamira, Estacao Experimental da EMBRAPA, km 23 rodovia Transamazonica, trecho Altamira-Itaituba, *R. P. Bahia 19* (NY); Serra dos Carajas, Serra Norte, ca. 20 km N of AMZA Exploration Camp, *C.C. Berg 595* (MG); Maraba, Carajas, Serra Norte Km 7 da Estrada de Ferro Carajas, *U.N. Maciel et al. 800* (MBM). **Paraná**. Antomina, *P. Dusén s.n.* (S). **Roraima**, Serra Tepequem, forest on upper west facing slopes, *G.T. Prance et al. 4453* (NY). **São Paulo**. Serra da Cantareira, portão de entrada da reserva, *J. B. Baitello 138* (MO); Serra da Cantareira-Chapada. proximo a entrada, guarita da guarda, *J. B. Baitello et al. s. n.* (SPSF); Serra da Cantareira, +ou- 900m acima da entrada principal, *J. B. Baitello et al. s.n.* (SPSF); Pariqueracu, Estacão Experimental do Instituto Agronomico de Campinas, a margem de uma capoeira, *G.A.D.C. Franco 493* (SPSF). Without precise locality. C. Feuillet 452 (MO); *Glaziou 12132* (G, GH). COSTA RICA. **Alajuela**: Los Chiles, R.N.V.S. Cano Negro, Llanura de Guatuso, alrededores de la Llanura Caño Negro, *R. Villalobos 171* (MO(2 dups)); Atenas, Atenas, *A. Smith 2440* (F). **Cartago**. Along the Río Sucio near Corinto, *L.O. Williams 16556* (BM, MO); Along spring run, slopes of La Carpintera above Tres Rios, *L.O. Williams 16147* (BM), 1km antes de

Pejiballe., *A. Jiménez 3801* (MO). **Guanacaste**. La Cruz, P.N. Guanacaste, Cordillera de Guanacaste, Finca Los Inocentes, *R. Espinoza 960* (MO (2 dups)). **Heredia**. Slopes of Volcán Barba, *K. S. Bawa 361* (MO); Along road above Gethsemini de Heredia., *G. Hartshorn 1209* (MO(2sheets)). **Limón**. North shore of the mouth of the Río Colorado, between the village and the Caribbean Sea, *G. Davidse & G. Herrera 30868* (MO). **Puntarenas**. Coto Brus, La Amistad, Cordillera de Talamanca, Estacion Pittier, Sendero Altamira, *A. Mora 8* (MO(3 dups)); Golfito, P.N. Corcovado, Península de Osa, Estación Sirena, alrededores Sendero Ollas, *R. Aguilar 2407* (MO (3 dups)); Buenos Aires, R. I. Ujarras, Cordillera de Talamanca, Ujarras, margen izquierda de Quebrada Dorora, camino a Río Lori, *G. Herrera 5858* (MO (4 dups)); Reserva Biológica Carara, Sector camino a Coope-Carara, R. L. Sitio Laguna Meandrica, *R. Zuñiga 244* (MO, F); **San José**: Pérez Zeledón, P. N. Chirripo, Cordillera de Talamanca, Sendero al Cerro Uran, *J. González 634* (MO (5 dups)); San Pedro de Montes de Oca, Ciudad Universitaria Rodrigo Facio, along N side of railroad tracks between Rte. 208 and Calle Central, *M. Grayum 7970* (F). CUBA. **Oriente**. Sierra de Nipe, Loma de estrella, *E.L. Ekman 6387* (G); Baracoa., *E.L. Ekman 4129* (G). **Santa Clara**. Buenos Aires, Trinidad Hills, *J. G. Jack 8733* (F). Without precise locality. *Eggers 4693* (BR, F (2 sheets), C, P); *C. Wright 476* (BR(2 sheets), NY, G(2 sheets)); *C. Wright 1411* (G, NY); *C. Wright 1406* (G(2 sheets), NY); *C. Wright 1407* (G(2 sheets), NY). DOMINICAN REPUBLIC. **Barahona**. Manantial, *A. & P. Liogier 27434* (NY); Without precise locality. *M. Fuertes 831* (BR, F, G). **Puerto Plata**. Cordillera Septentrional, Lomas de Jagua, *E. L. Ekman 14418* (C, G). **Pedernales**. Las Abejas, Aceitillar, *A. & P. Liogier 26785* (NY). Without precise locality. *M. Poiteau s. n.* (G(2 sheets), P); *J. G. Scarff s.n.* (F). ECUADOR. **Bolivar**. Valle de Tablas, descenso de la Cord. Occidental, *M. Acosta 6005* (F). **Carchi**. Near

Maldonado, *H. van der Werff & E. Gudiño 10744* (MO (5 dups)). **Imbabura**. Lita, *W. Palacios 5197* (MO(11 dups)); In valley of Río Meta along border of Carchi Province, between Ibarra and Lita, 12 km E of Lita, *T. Croat 38988* (MO). **Morona-Santiago**. Bomboiza. cercanías de la Misión Salesiana-Shuar, *D. Neill et al. 7484* (MO(4 dups)); Río Cuyes y via Bomboiza-Gualaquiza, *W. Palacios 1445* (MO(6 dups)); Morona Santiago, Via Plan de Milagro-Limón Indanza, *W. Palacios & H. van der Werff 3721* (MO (6 dups)); campamento La Playa, road construction camp 23km SE of San Juan Bosco, *A. Gentry et al. 30935* (MO). **Napo**. Archidona, Volcán Sumaco, Carretera Hollin-Loreto, km 50. Comunidad Guagua Sumaco, *D. Rubio & A. Alvarado 2413* (MO (2 dups)); Baeza-Cosanga, colecciones en potrero nublado, *J. Jaramillo 10091* (NY). **Pichincha**. Along road near Nanegal, in pasture land or small forest remnants, *H. van der Werff et al. 12315* (MO(14 dups)); Quito, Reserva Biológica Maquipucuna, Nanegal, *G. Tipaz et al. 590* (MO(3 dups)). **Zamora-Chinchipe**. Nangaritza Cantón Río Nangaritza, Pachicutza, Orillas del Río Nangaritza, *W. Palacios et al. 6783* (MO(8 dups)). Without precise locality. Parroquia Nanegalito, Cerro Negro, *G. L. Webster 31313* (MO). GUATEMALA. **Petén**. Cadenas Road, bordering Machaquila River, in village clearing, *E. Contreras 9796* (ENCB, MO, P). HAITI. Massif de la Salle, Petionville, Fourcy, *E.L. Ekman 3207* (MEXU); Vicinity of Bassin Blue, *E. C. Leonard et al. 15037* (NY). HONDURAS. 1.8 mi strip on the north bank of rio Guaimoreto between old bridge and opening of Laguna Guaimoreto, 4.5 mi NE of Trujillo on old road to Castilla, *J. Saunders 459* (NY). JAMAICA. **Middlesex**. St. Catherine, James mountain, 1 mile east of Sligoville, *G. R. Proctor 31739* (ENCB, NY, F); Manchester, Old England, *W. Harris 5257* (C); Manchester, Old England, *W. Harris 5259* (BR, G); Manchester, vicinity of Mandeville, *S. Brown 268* (NY). **Surrey**. St. Thomas, Blue Mountains, *W. Harris 5099* (C, BR,

NY, G(2 sheets)). Without precise locality. Along track between Norwood & Bailey, *G. R. Proctor 38125* (NY); Farm Hill Works, *W. Harris 5540* (F, BR, G(2 sheets)); *G. R. Proctor et al. 22007* (ENCB, BR, NY); *R. C. Alexander s. n.* (NY (2 sheets), P). MEXICO. **Chiapas**. Escuintla, *Eizi Matuda 2632* (LL); Esperanza, Escuintla, *E. Matuda 17446* (F); Bachajón, slope along stream, montane rain forest 3 km N Bachajon-Ocosingo road on road to Palenque, *D.E. Breedlove 50903* (MO, MEXU); Villa Corzo, Colonia Vicente Guerrero on road to Finca Cuxtepec, *D.E. Breedlove 50720* (MO); Ocosingo, Nvo. Guerrero sobre el camino Palenque-Boca Lacantúm, *E. Martínez S. 18131* (MO); Ocosingo, en Crucero Corozal sobre el camino Palenque-Boca Lacantúm, *E.M. Martínez 12079* (MO). Without precise locality. *F. Miranda 7655* (MEXU). **Oaxaca**. Pluma Hidalgo, Dto. Pochutla, San Pedro Cafetitlan - Union de Guerrero, *S. Acosta 1240* (CIIDIR (3 dups)); Vicinity of Cafetal Concordia., *C. V. Morton et al. 2444* (F); Pochutla, Río Concordia, 9km al NE de la desviacion al cafetal concordia, hacia Pluma Hdgo, *R. Torres et al. 669* (MO). **Veracruz**. San Pedro Tlapacoyan, Martínez de la Torre, *F. Ventura 19937* (MEXU); Río Escondido, Puente Nacional, *F. Ventura 16960* (MEXU); a 18 km de Martínez de La Torre rumbo a Misantla, *M. Martínez 71* (MEXU); Hidalgotitlán, *Brigada Vázquez 366* (MEXU); 1 km al Norte del campamento Hnos. Cedillo, Hidalgotitlán, *Brigada Vázquez 387* (MEXU); Sta. Ana Atzacan, Dos Rios, *C. Velázquez 142* (MO); Catemaco, 5km al norte de Catemaco, camino a Sontecomapan, *R. Cedillo et al. 127* (MO); Rio Soloxuchil al SW del campamento Hnos. Cedillo, Hidalgotitlán, *F. Ponce 259* (MO); Zacuapan, *H. Galeotti 7026* (BR); Zacuapan, *C. A. Purpus 14327* (F); Martínez de la Torre, San Pedro Tlapacoyan, *F. Ventura 19937* (ENCB); near Xalapa, *H. Galeotti 7026* (G); Hueyapan de Ocampo, Ejido Barrosa, carretera Catemaco- Coatzacoalcos, R. *Cedillo 3072* (XAL); Zacuapan, *C. A. Purpus*

15337 (F); along road from Catemaco to Sontecomapan, 2.5km N of Laguna de Catemaco and junction with Catemaco-Coyame road, 5km NE of Catemaco, *M. Nee & K. Taylor 26720* (NY, MO, F); Coetzalan, por el camino a Coetzapotitla, *V. Vazquez 412* (NY); Conejos, mpo. Puente Nacional, *F. Ventura 12695* (ENCB, IEB, XAL); Tezonapa, Ejido Maravilla, *R. Robles 720* (XAL); Coxquihui, 1 km al N de Sabanas de Xalostoc, *P. Tenorio et al. 8610* (IEB, MEXU); Ocozocoautla, near a small spring 13-15km south of Ocozocoautla along to Villa Flores, *D.E. Breedlove 24594* (MO); Mirador, *Linden 20* (BR, MO); Valle de Córdoba, *E. Bourgeau 2302* (G); Fortín, Coatzacoalcos river, *L. Williams 8920* (F); Nautla, Cuatro Caminos, cerca de Cerro Chico, *F. Ventura 3595* (MO(2dups)); Barranca de Fortín, Córdoba, *G. Woronov 3089* (F).

NICARAGUA. **Boaco**. Camino a cerro Mombachito, ca. 4.5 km NW de Camoapa, *A. Grijalva 2844* (MO); ca. 17km al N de Camoapa, Comarca San Isidro, *A. Grijalva et al. 3894* (MO); Camino a Mombachito, a los dos lados de la Quebrada Río Grande al NE de Cerro Mombachito, *P. Moreno 3219* (MEXU). **Chontales**. 3 km N of Cuapa, *D. Neill 2481* (ENCB); Hda. Veracruz, including Cerro La Batea and Cerro Los Charcos, *W.D. Stevens 22371* (MO); Hda. Corpus, 11 km W of Juigalpa, *J. S. Miller et al. 1335* (MO); Vicinity of Juigalpa, *P. C. Standley 9308* (F); Cerro Oluma, on ridge top of Cordillera Amerisque, *A. Gentry et al. 43953* (MO); Cerro Oluma, *A. Gentry et al. 43971* (MO). **Matagalpa**. Cordillera Central de Nicaragua, about 4-6km N of Santa Maria de Ostuma, *L.O. Williams & A. Molina 42520* (BM); Carretera al Tuma, 6km NW de Cuatro Esquinas, *M. Guzman et al. 847* (MO); Carretera a Jinotega, entrada Tapacón de Palcila, a 9 km de Matagalpa, *P. Moreno 3361* (MO); Comarca Yasica Norte, finca La Castilla, 26 km NE de la ciudad de Matagalpa, *M. Guzman et al. 227* (MO). **Nueva Segovia**. 2 km de Murra, orilla de Quebrada La Mula, "Las Gallineras", *P. Moreno 5882* (MO). **Zelaya**. NW de

Colonia Río Plata, 4 km de Nueva Guinea. Bosque de galeria a lo largo de Río Plata, *J. C. Sandino 4516* (MO). Sur del Río Wawa, 60 km NO de Puerto Cabezas, *E. Little 25212* (MO). PANAMA. **Canal Zone**. Hospital Grounds at Ancón, *H. Pittier 2750* (BM); Barro Colorado Island, in cove near Slothia, *R. Foster 2369* (F). **Darién**. Western slopes of Serranía de Pirre, below Cana mine, along old road to Boca de Cupe, *G. McPherson 12244* (MO(4dups)); Cana, near Río Setigandi, *A. Gentry et al. 28548* (BM, G); Western slopes of Serranía de Pirre, below Cana mine, along old road to Boca de Cupe, *G. McPherson 12231* (MO); Río Pucro, below village of Pucro, *J. A. Duke 13124* (NY). **Panamá**. San José Island, Perlas archipelago, Gulf of Panama, (about 55 miles SSEof Balboa), *I. M. Johnston 697* (A(2 sheets)); San José Island, Perlas archipelago, Gulf of Panama, *I. M. Johnston 505* (BM); San José Island, Perlas archipelago, Gulf of Panama, East road east of Red Hill, *I.M. Johnston 553* (BM, MO, US); San José Island, Perlas archipelago, Gulf of Panama, *I. M. Johnston 666* (S); San José Island, Pearl Archipelago, Northern half of island, *C. O. Erlanson 16* (G); San José Island, Perlas archipelago, Gulf of Panama, *I. M. Johnston 667* (S). **Veraguas**. Isla Coiba, Distrito de Montijo, Cerro de La Torre, *C. Galdames et al. 2336* (MO). Without precise locality. *S. Hayes s. n.* (BM). PARAGUAY. **Amambay**. Santo Tomás, Sierra de Amambay, *E. Hassler 11305* (S); cerca de Cerro Guazu Amambay, *M. Bernardi 19203* (MBM). **Canendiyu**. Cerca de Guadelupe, *M. Bernardi 18249* (F, K, MBM). PERU. **Ayacucho**. Eastern massif of the Cordillera Central opposing the cordillera Vilcabamba between Tambo, San Miguel, Ayna and the Hacienda Luisiana, *T. R. Dudley 11727* (F). **Cuzco**. La Convención, *T. R. Dudley 10309* (F). **Huánuco**. Churubamba, Hacienda Exito, bank Rio Ysabel, *Y. Mexia 8160* (K, MO, F). Huamalico, Monzon, *A. Weberbauer 3487* (G). **Junín**. Pichis Trail, km 3-10, *E. P. Killip & A. C. Smith*

25430 (US, NY, F). Satipo, Puerto Ocopa, *C. Reynel 324-CRR* (MO). **Pasco**. 7 km N of Cacazu, *A. Gentry et al. 63251* (MO (8 dups)); Oxapampa, Oswaldo Muller property, *D. N. Smith 5349* (MO). **San Martín**. Venceremos, near Amazonas border, Km 291 on Rioja-Poma-cocha road, *A. Gentry et al. 45370* (MO). Venceremos, near Amazonas border, Km 291 on Rioja-Poma-cocha road, *A. Gentry & D.N. Smith 45246* (MO); Rioja, Vicinity of Puente Serranoyacu, S side of valley, *M. L. Luna 98* (MO). Without precise locality. *Pavón & Ruiz s.n.* (BM); *Pavón s.n.* (G (2 sheets)); *Poeppig 1311* (G(2 sheets), NY, BM, W); *Dombey 201* (F). PUERTO RICO. El Yunque, *R. Woodbury 4691* (MO). Without precise locality. *P.Sintenis 6810* (W, BR, G (5 sheets), F); *P. Sintenis 6522* (BR (2 sheets), G (3 sheets), F, NY, BM, P,). TOBAGO. Charlotte Ville, *W. E. Broadway 4274* (BM). VENEZUELA. **Anzoategui**. Woods along Río León by Quebrada Danta, tributary to Río Neveri, NE to Bergantin, *J.A. Steyermark 60989* (F); headwaters of Río Maravilla, slopes of Fila Grande, between Los Chorros and Cerro Negro, east of Bergantin, *J.A. Steyermark 61720* (VEN). **Apure**. Distritos Pedro Camejo y Achaguas, Parque Nacional " Santos Luzardo " (Capanaparo-Cinaruco). Mata sobre medano, ca. del Fundo Coco de Mono, *R. Gómez et al. 769* (VEN). **Barinas**. Pedraza, East of Carrizal (La Escaza on maps) along the south bank of the Río Canagua on the trail to Santa Gertrudis, Parque Nacional Sierra Nevada, *L.J. Dorr et al. 5669* (MO); Río Quio al Oeste de Barinas, *R. Smith 5102* (VEN); Pedraza, Trail from Mesa de Canagua to Alto de La Aguada, 23km NW of Curbati., *L.J. Dorr et al. 4750* (MO). **Delta Amacuro**. Tucupita, mountain area ca. 13 km by road ESE of the town of Sierra Imata, *G. Davidse & A. González 16530* (G). **Distrito Federal**. Cerro "El Avila", vertiente sur, pica "Los Pinabetes", región de antiguos cafetales, *W. Meier 3599* (MO); Cordillera de la Costa, Cerro El Avila, vertiente sur, a lo largo de la pica "Guayabo Mocho", arriba de Los

Venados, *W. Meier 2430* (MO). **Falcón**. Bolívar, 1km E of Carrizalito, Sierra de San Luis, along road 1km E of Piedra Prenda, *H. van der Werff et al. 8725* (MO(10 dups)); Sierra de San Luis, carretera Zambrano-San Luis, entre La Soledad y Curimagua, *F. Lorea et al. 5568* (MO(5 dups)); Sierra de San Luis; entre La Tabla y la bifurcacion de la carretera hacia el Hotel Parador, *J.A. Steyermark 99054* (NY); Camino Zambrano-Curimagua, Sierra de San Luis, *F. Lorea et al. 5569* (MO(3 dups)); Camino Zambrano-Curinagua, Sierra de San Luis, *F. Lorea & G. Carnevali 5571* (FCME (5 dups)); Serranía de San Luis, along road between Curimagua and San Luis, on road to microwave station 6.1 km S of Curimagua, 7 km above turnoff to station, *T. Croat 74545* (MO (3 dups)); Serranía de San Luis, along road between Curimagua and San Luis, 5.5 km S of Churimagua, *T. Croat 74530* (MO (3 dups)); Paraguana. Selva nublada del cerro Santa Ana, *T. Lasser & L. Aristeguieta 3408* (F); Miranda, Carretera La Negrita-Curimagua el paso entre La Negrita y Curimagua, *L. Marcano Bert 415-979* (BR (Plantetum), VEN); Península Paraguana. Cerro Santa Ana., *F.J. Breteler 4312* (NY); Península Paraguana. Cerro Santa Ana., *F.J. Breteler 4312* (P, MBM). **Lara**. Al oeste de Duaca en la zona de caf'e, *R. Smith V 5219* (VEN); al sur de Río Claro, *José Saer s.n.* (F). **Mérida**. Vicinity of Tovar, in small woods, *H. Pittier 12768* (G, MO); Carretera Santa Cruz de Mora - El Maporal, *L. Valverde et al. 1121* (MO); Páramo Laguna Negra, Mucubaji, entre Laguna Grande y Laguna Negra, *Bernardi 11050* (NY); Guaraque, Quebrada Huesca, *L. Marcano Berti 1747* (G); Circa Chiguara, *Bernardi 11050* (G); Vicinity of Tovar, in small woods, *H. Pittier 12768* (NY). **Miranda**. Guaicaipuro, San Diego de Los Altos, *S.S. Tillett et al. 927-17* (MO). **Monagas**. Caripe, *E. L. Little et al. 16052* (VEN); Caripe, Camino Cueva del Guácharo-Cerro Negro, *C. Bosque CB-16* (MO); Caripe, Cueva del Guácharo, *C. Bosque CB-41* (MO); Caripe, Carretera La Guanota-Juasjuillar, *C. Bosque CB-1* (MO(2

sheets)); Monumento Natural Alejandro de Humboldt, en los alrededores de la Cueva del Guácharo, *W. Meier et al. 3581* (MO); Vicinity of La Cuchilla, between Guanaguana and Guácharo, *J.A. Steyermark 62557* (VEN); Caripe, Cueva del Guácharo, *C. Bosque CB-7* (MO); Caripe, *P. Lau 15* (MO); without precise loclity, *J.A. Steyermark 61904* (VEN). **Sucre**. Cagigal, Península de Paria, trail from El Paujil to summit of the mountain, south-facing slopes, trail leading to El Brasil, *J.A. Steyermark et al. 121416* (G(2 sheets), MO). **Táchira**. Entre Villa Páez y Tama, arriba del Río Táchira, a lo largo de la frontera Colombo-Venezolana, *J.A. Steyermark 98846* (NY (2 sheets)); Cárdenas, Arriba de Toituno, *Jose Bono 4934* (MO); Forested slopes bordering Quebrada Colorada, between San Juan de Colón and Las Cruces, al La Pocina, *J.A. Steyermark et al. 120319A* (MO); Cárdenas, Arriba de Capacho, hacia la cumbre, José Bono 4934 (MO); Delicias, Junin, Caserío Villa Páez y sus alrededores, a orillas de potreros y caminos en bosques residuales, *L. Ruíz Terán 895* (MO, G). **Trujillo**. Carache, near La Cuchilla, Trujillo, *H. Pittier 13337* (F, MO); Morón, vía las Pavas, Cruzando el puente sobre el Río Buena Vista, *J. A. Farreras et al. 84* (MO). **Yaracuy**. Sierra de Aroa, 15-20km NW of Cocorote on road to Aroa, from 1km SE of Los Cruceros to El Refugio.Ca 11km W of San Felipe air distance, *R. Liesner et al. 10097* (VEN, MO); Urachiche, 20km al norte de Urachiche, *Aymard et al. 1614* (MO). **Zulia**: Bolívar, Entre El Pensado (aldea unos 4 km al este de Quiros) y Las Tres Marias, *G.S. Bunting & A. Stoddart 9063* (NY); Mara, Northwestern wooded slopes of Cerro Negro, between hacienda Santa Clara and Hacienda Tonchala, 5.5 km SW of Rancho 505, S of Río Guasare, *J.A. Steyermark et al. 122737* (MO, VEN); Miranda, Entre la via El Consejo-El Pensado y el límite con el Edo. Falcón, desviando en el "Arbol del Mene", un poco al W de Quiros, *G. S. Bunting & A. Stoddart 8842* (NY). Without precise locality, *L. Ruíz-Terán et al.*

10441 (MO); *J.A. Steyermark 60989* (VEN).

Cinnamomum uninervium Lorea-Hernández, sp. nov. TYPE. Brazil. Minas Gerais: Mpo. Gouveia, Serra do Barro Preto, km 66 on road Curvelo - Diamantina, (fl, fr), 4 September 1982, *A. Furlan et al. 3230* (holotype, SPF; isotypes, FCME, MEXU, MO).

Frutices parvi. Folia anguste elliptica, apice obtuso vel acutato, pinnatinervia (vel subtriplinervia?), infra glabra, venae secundariae et minor inconspicuae; domatiis carens. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis carens. Flos tepalis extus sicut pedicello glabris, hypanthio intus glabro; tepalis integris in fructu persistentibus (interdum partim persistentibus?).

Shrubs up to 1.5 m tall; twigs usually ridged or narrowly winged, ridges coming from petiole bases, glabrous, sometimes inconspicuously pubescent near the terminal bud, hairs 0. mm long, straight, appressed; petiole 1 - 2 (2.5) mm long, (0.6) 0.8 - 1 (1.3) mm wide, glabrous; leaf blades (1) 2.5 - 4.5 (5) cm long, (0.4) 0.8 - 1.3 (1.5) mm wide, narrowly elliptic, apex obtuse to acute, base acute, glabrous above and below, penninervate to subtriplinerved (?), midvein slightly marked above, slightly raised below, glabrous, secondaries (6) 8 - 10 pairs, barely distinguishable from tertiary veins, flat above and below, glabrous, tertiary veins flat above and below, domatia absent; inflorescence (2.5) 4 - 8 cm long, axillary to leaves, cymose-paniculate, peduncle (0.1) 0.7 - 1.5 (2) cm long, glabrous, rachis glabrous, flower pedicel (3) 4 - 4.5 mm long, glabrous; flower pale yellowish white, tepals 1.9 - 2.4 mm long, 1.5 - 1.7 mm wide, ovate,

glabrous outside, outer ones sparsely sericeous on central basal area inside, otherwise glabrous, inner ones sparsely sericeous all over inside, red hairs present, stamens of whorls I & II 1.3 - 1.7 mm long, filaments glabrous ad and abaxially, anthers 0.8 - 0.9 mm long, glabrous ad and abaxially, sporangia four, in two pairs, introrse, stamens of whorl III 1.3 - 1.7 mm long, filaments sparsely long sericeous adaxially, red hairs present, glabrous abaxially, anthers 0.7 - 0.8 mm long, sparsely long sericeous adaxially on lower half, red hairs present, glabrous abaxially, sporangia four, in two pairs, upper ones latrorse, sometimes aborted, lower ones extrorse, glands 0.5 mm long, at base of filament, round, glabrous except for few sericeous hairs adaxially at point of attachment, staminodes 0.8 - 1 mm long, pedicel glabrous adaxially or few scattered red hairs present, sparsely sericeous abaxially, some red hairs present, head 0.5 - 0.7 mm long, cordate in outline, glabrous adaxially, sparsely long sericeous abaxially, mainly along median section, hypanthium 0.5 mm deep, glabrous outside and inside, or some red hairs present at base of staminodes and third whorl stamens, pistil 1.5 - 1.9 mm long, glabrous, ovary 0.7 - 0.8 mm long and wide; fruit 7.5 - 9.5 mm long, 5 - 5.5 mm wide, ellipsoid, cupule 3.5 - 5 mm long, 3.8 - 4.5 mm wide, pedicel 1.5 - 5 mm long, 0.7 - 0.9 mm wide, tepals persistent (some partially so).

Flowers in September(?) and April (?); fruits in September and April (?). This species is known only from Campo Cerrado vegetation in central Minas Gerais, Brazil.

This species is maintained in *Cinnamomum* for the characters it presents in flowers and fruits, in spite of having no distinct triplinerved leaves neither domatia. The syndrome of features is the same found for other neotropical species, like *C. amplexicaule*, *C. chiapense*, and *C.*

quadrangulum. Leaf shape and size separates the present species from the others. The rather inconspicuous secondary veins make the leaves look like with a single middle vein, characteristic from which the name is derived.

Cinnamomum velvetii Lorea-Hernández, sp. nov. TYPE: Mexico. Guerrero: Mpo. Mochitlán, Cerro de La Vaca, aprox. 2.5 km W of Agua de Obispo, 1000 - 1500 m, 6 May 1987, (fl, fr), *L. Rodríguez 59* (holotype, FCME; isotype, MO).

Frutices. Folia plerumque lanceolata, apice acutato vel longo acuminato, lamina pinnatinervia vel (raro) triplinervia, infra dense tomentosa trichomatibus undulatis, patulis, particulis ceraceis etiam abundantibus; domatiis praesentibus ad axillas nonnullas venarum secundariarum, saepe indistinctis, pagina foliari utrinque ad domatia subplana, aut supra leviter prominens. Inflorescentia ex cymis in paniculam aggregatis constans, plerumque bracteas foliaceas satis persistentes gerens. Flos tepalis extus sicut pedicello tomentosis, hypanthio intus glabro praeter verticem disperse pubescente; tepalis integris in fructu persistentibus.

Shrubs up to 3 m tall; twigs densely vilose-tomentose, surface concealed by the indument, hairs 0.4 - 0.6 mm long, spreading to more or less erect, wavy, pale yellow, persistent; petioles (3) 4 - 6.5 (7) mm long, 1 - 1.6 mm wide, densely vilose-tomentose, hairs as on twigs; leaf bldes (3) 5 - 8.5 (11) cm long, (1) 1.5 - 2.5 (3.5) cm wide, lanceolate, rarely ovate or elliptic, apex acute to long acuminate, base obtuse to acute, sometimes oblique, tomentose above when young, indument pale yellow, red hairs intermixed with it, glabrescent with age, densely

tomentose below, surface covered by an almost continuous layer of white waxy particles, indument persistent, pinnate to subtriplinerved, rarely triplinerved, midvein slightly marked to flat above, tomentose, red hairs present, conspicuous, indument rather persistent, strongly raised below, densely tomentose, secondary veins (6) 7 - 9 (10) pairs, flat to slightly raised above, glabrescent, raised below, particularly the lowest pair, tomentose, tertiary veins flat or slightly raised above, glabrous, slightly raised below, tomentose, primary domatia apparently present but not distinct, secondary domatia absent; inflorescence (4.5) 6 - 9.5 (10.5) cm long, axillary to leaves, cymose-paniculate, foliose bracts often present at main branchings, peduncle (3) 4 - 6.5 cm long, tomentose, rachis tomentose, flower pedicel 2.5 - 4.5 (6) mm long, tomentose; flower urceolate, tepals 1.8 - 2.1 mm long, 1.3 - 1.8 mm wide, ovate to wide ovate, tomentose outside, red hairs present, sericeous inside, red hairs present, stamens of whorls I & II 1.2 - 1.4 mm long, filaments sparsely sericeous ad and abaxially along the median section, anthers 0.7 - 0.9 mm long, glabrous adaxially, glabrous abaxially or sparsely sericeous at the very base, theace four, in two pairs, introrse, stamens of whorl III 1.2 - 1.4 mm long, filaments (long) sericeous on the margins adaxially, sparsely sericeous along the median section abaxially, anthers 0.6 - 0.8 mm long, sericeous adaxially, except along the connective, glabrous abaxially, sporangia four, in two pairs, the upper ones latrorse, the lower ones extrorse (latrorse), glands 0.4 - 0.5 mm long, at the base of filament, ovate, sericeous adaxially at median section, glabrous elsewhere, staminodes 0.7 - 0.9 mm long, pedicel glabrous or sparsely sericeous at base adaxially, long sericeous abaxially, head 0.5 mm long, triangular in outline, glabrous adaxially, long sericeous abaxially, mainly on lower two thirds, hypanthium 0.4 mm deep, tomentose outside, glabrous inside except for big patches of sericeous hairs between the base of third stamens and staminodes, pistil 1.6 -

1.9 mm long, glabrous, ovary 1 - 1.2 mm long, 0.9 - 1.2 mm wide; fruit (still immature) 8 - 8.6 mm long, 5.2 - 5.8 mm wide, ellipsoid, cupule 5 - 5.3 mm long, 3.2 to 1.4 mm wide, no pedicel; tepals persistent.

Flowers in May and June. Fruits ripe in November. In pine and oak - pine forest, at an altitude between 850 - 920 (1500?) m.

Paratypes. MEXICO. **Guerrero**: Mpo. Chilpancingo, on the trail from Zoyatepec to Cerro de La Vaca, (fl), *L. Rodríguez 333* (FCME, MO); 3.5 km N of Zoyatepec, 920 m, (fr), *E. Martínez 2573* (MEXU); Barranca de El Toro, aprox. 3 km WNW of El Ocotito, 850 m, (fl), *F. Lorea 5500* (FCME, MO).

Type of indument suggests a relationship to *C. kruseanum*, but leaves mostly lanceolate with apex acute to acuminate, and particularly leaf base obtuse not amplexicaul, keep separate *C. velvetii* from that species.

Cinnamomum zapatae Lorea-Hernández, sp.nov. TYPE: Mexico. Guerrero: Mpo. Chichihualco (Leonardo Bravo), 3 km NE of Cruz de Ocote, between Filo de Caballos and Puerto El Gallo, 2250 m, (fl, young fr), 14 January 1988, *F. Lorea 4172* (holotype, FCME; isotypes, FCME, MO).

Arbores. Folia plerumque ovata vel late ovata, apice acutato vel breviter acuminato,

triplinervia aut subtriplinervia, infra dense pubescentia trichomatibus undulatis vel crispis, adpressis vel patulis; domatiis praesentibus ad axillas nonnullas venarum secundariarum et tertiariarum, pagina foliari utrinque ad domatia subplana. Inflorescentia ex cymis in paniculam aggregatis constans, bracteis foliaceis nonnunquam praesentibus, deciduis. Flos tepalis extus sicut pedicello pubescentibus, hypanthio intus dense pubescente; tepalis integris in fructu persistentibus.

Trees ca. 25 m tall; twigs densely pubescent, hairs 0.2 - 0.5 mm long, appressed to erect, mostly wavy or curly, long persistent; petioles (9.5) 11 - 17 (20) mm long, (0.8) 1.3 - 2 mm wide, densely pubescent, hairs as on twigs; leaf blades (5) 8 - 13 (16) cm long, (2.5) 4 - 6.5 (9.5) cm wide, ovate to widely ovate, occasionally elliptic, apex acute to acuminate, base obtuse to rounded, sometimes oblique, pubescent when young above, soon glabrous, densely pubescent below, hairs as on twigs, rather persistent, sometimes deciduous in part of the leaf area, triplinerved or subtriplinerved, midvein slightly marked above, glabrous, strongly raised below, densely pubescent, hairs wavy to curly, spreading to erect, secondary veins (3) 4 - 5 pairs, rather flat above, strongly raised below, densely pubescent, hairs as on midvein, tertiary veins flat above, raised to strongly raised below, pubescent to sparsely pubescent, primary domatia present in most of secondaries axils, secondary domatia present, mostly along basal pair of secondaries, tertiary domatia occasionally present; inflorescence (3) 6.5 - 11 (13.5) cm long, axillary to leaves, simple, branched from the base, or in short racemes, cymose paniculate, peduncle 0.5 - 3.5 (5.5) cm long, or absent, densely pubescent, rachis densely pubescent, flower pedicel 2.5 - 5 (7) mm long, pubescent; flowers urceolate, tepals 2.3 - 2.7 mm long, 1.6 - 2.3 mm wide, ovate or

widely ovate, pubescent outside, sericeous inside, some red hairs present, stamens of whorls I & II 1.6 - 1.8 mm long, filaments glabrous adaxially, glabrous or sparsely sericeous abaxially, anthers 0.7 - 1.1 mm long, glabrous ad and abaxially, or sparsely sericeous on base abaxially, sporangia four, introrse, stamens of whorl III 1.7 - 2 mm long, filaments sericeo-tomentose adaxially, red hairs sometimes present, sparsely long sericeous abaxially, particularly on lower half, anthers 0.7 - 1 mm long, sparsely sericeo-tomentose adaxially on lower half, glabrous abaxially, sporangia four, upper ones latrorse, lower ones extrorse, glands ca. 0.5 mm long, above filament base or higher, roundish, long sericeous adaxially, glabrous abaxially, staminodes 0.9 - 1.1 mm long, filaments (red) sericeo-tomentose adaxially, sericeous abaxially, head 0.5 - 0.7 mm long, wide cordate in outline, acuminate, glabrous adaxially, sparsely long sericeous on lower half abaxially, hypanthium 0.5 deep, pubescent outside, sericeous inside, red hairs abundant, pistil 2 - 2.3 mm long, glabrous, ovary 0.8 - 1.2 mm long, 0.9 - 1.2 mm wide; fruit 9 - 15.5 mm long, 6 - 10 mm wide, cupule 5 - 9.5 mm long, 5 - 8.5 mm wide, narrowing to a bottom 1.5 - 2.5 mm wide, pedicel not distinct, tepals persistent.

Flowers are present in January, April, and May. Fruits are ripe in December, January, and February. The habitats of this species are mainly the cloud forests and pine-oak forests that grow along the mountain ranges that run across southern Mexico and adyacent Guatemala, between (1300) 1600 - 2450 (2750) m of altitude.

Paratypes. MEXICO. **Guerrero**: Mpo. Chichihualco (Leonardo Bravo), 3.5 km NE of Cruz de Ocote, 2100 m, (fr), *F. Lorea 5489* (FCME, MO); Mpo. Chilpancingo, 2 km E of

Omiltemi on the road to Chilpancingo, 2250 m, *J. Rzedowski 16071* (ENCB). **Oaxaca**: Rancho Grande, *F. Miranda 1097* (MEXU); Mpo. Laxopa, 20 km E of Ixtlán along road to Talea de Castro, 2450 m, (fl), *G. Martin 514* (MEXU, MO); 25 km SSW of Talea de Castro, 3 km N to Yalina junction, 2750 m, (fl), *R. Cedillo & D. Lorence 2373* (MEXU); Mpo. Ixtlán, on the road from Calpulalpan to Llano Verde, ca. 15 km N of Calpulalpan, 2400 m, (fl, fr), *R. Cedillo & D. Lorence 2368* (MEXU, MO). **Chiapas**: Mpo. Tenejapa, Ojo del Río Yash Zanal, 1600 m, (fr), *A. Méndez 5332* (MEXU, MO); Mpo. Angel Albino Corzo, Reserva El Triunfo, 1930 m, (fr), *L. Avila & S. Solórzano 30* (CHIP, FCME). GUATEMALA. **Alta Verapaz**: along Río Cobán, 4 km E of Cobán, 1300 m, (fr), *L. Williams et al. 43353* (F, NY).

The pubescence made of wavy to curly hairs, along with the strongly raised secondary and tertiary veins, secondary domatia, and fruit pedicel turbinate from top to bottom distinguish this species from those other related to it morphologically, like *C. bractefoliaceum*, *C. padiforme*, and *C. tonduzii*. *C. glossophylum*, which also has the same kind of pubescence, differs in leaf shape.

This species is named after E. Zapata, a Mexican revolutionary that fought in southern Mexico for the vindication of basic rights of indigenous people.

Taxonomical comments.

As accepted here, *Cinnamomum* in the Neotropics encompasses a group of species that touches other genera in different points. From the set of characters utilized to separate the species ascribable to this genus, the combination of perfect flowers with erect tepals, well developed

staminodes at whorl IV, and tepals whole or partially persistent on the rim of the cupule, is diagnostic. Most of the species can be recognized by this set of characters as belonging to *Cinnamomum*. However, the species that present pinninerved leaves without domatia, are closer morphologically to either *Persea* or *Ocotea*. On the one hand, species like *C. amplexicaule*, *C. chavarrianum*, *C. erythropus*, *C. quadrangulum*, *C. subsessile*, *C. uninervium*, and *C. velvetii*, differ from *Persea* only in that they have a distinct hypanthium. On the other hand, *C. formicarium* differs from *Ocotea* only by the presence of well developed staminodia. Even *C. hammelianum* and *C. napoense* could be considered *Ocotea* species if not for the presence of well developed staminodia and tepals partially persistent in the cupule. Since we don't have any indication of how the character syndrome observed in *Cinnamomum* was attained during evolution, we can not be sure that species with those traits conform a single defined clade; the same remark is also true for the genera *Persea* or *Ocotea* mentioned above. Therefore, in one case we can see the *Cinnamomum* species referred before as *Persea* species that have grown hypanthium or, in the other case, as *Ocotea* species that have well developed staminodes. In fact, there is a group of species recognized in *Ocotea* that have perfect flowers and glandular staminodia (*O. indecora* group; Rohwer, 1986), which stress a possible connection of these two genera.

In addition to the characters listed above for *Cinnamomum*, the presence of domatia is a feature also found in several *Ocotea* species, while stamens of whorl III with two sporangia occurs in some *Persea* species. Although in these instances it seems to be a matter of parallel evolution, for the core of diagnostic characters of these genera (*Cinnamomum*, *Ocotea*, and *Persea*) persists in those species that diverge in the presence of domatia or lower number of

anther cells. An extreme case of variation for these characters can be found in a species that I decided to place in a new genus I named *Mocinnodaphne*. In this taxon, floral features are like in *Licaria* (only the three innermost stamens are fertile, with two sporangia), but fruit and foliar characters resemble *Cinnamomum* (persistent tepals in fruit, triplinerved leaves with domatia). It is clear, from this case, that parallel evolution of these traits is rather common among several taxa in the Lauraceae. Although I considered *Mocinnodaphne* related with *Cinnamomum* (and some other genera like *Nectandra* and *Ocotea*), in the cladistic analyses it never came close to any of these genera, but close to *Licaria* (see below).

In the end, however, if to the core of flower and fruit characters, the condition of triplinerved to subtriplinerved leaves with domatia is added, most of the neotropical species of *Cinnamomum* form a very distinctive taxon. This situation implies these species probably constitute a real phylogenetic line within the Lauraceae. Support for this statement was found in the results of the phylogenetic analysis.

Excluded species.

Exclusion of species from *Cinnamomum* was based on the use of combination of characters that currently are considered to recognize genera in the Lauraceae. Thus, most species included in this list fit better in *Ocotea*, namely by the presence of pinninerved leaves, tepals spreading at anthesis, staminodia stipitiform, and tepals not persistent in fruit. Several species formerly in *Cinnamomum* have been already moved to *Ocotea*, and the proper combinations under this genus are cited for those taxa.

Except for a couple of new names presented here where no taxonomical ambiguity exists, there are a number of species for which no new combinations have been made. The reason to do this is for the sake of not increasing the number of synonyms in the family, for there was no time nor appropiate herbarium material to define safely the correct names of those species.

Few excluded species belong to *Nectandra* or *Persea*. While the species included in the former genus do not have problem to be placed in it (for the presence of papillose tepals and/or stamens, and anther cells arrenged in an arch), the species included in *Persea* do not fit perfectly there, for they have tepals about the same size, persistent in the fruit, and a narrow hypanthium that do not broaden out with the growing fruit (not known in *Persea areolatocostae*).

The presence of only two celled stamens, and other floral and vegetative characters do leave no doubt of the inclusion of two species in *Aiouea*.

Cinnamomum acutatum Kostermans, Reinwardtia 6: 20. 1961. ≡ *Phoebe acuminatissima* Lundell, Contr. Univ. Michigan Herb. 6: 19. 1941. Type. Mexico. Chiapas: Mt. Ovando.

Matuda 2107 (holotype, MICH!; isotypes, A!, LL!, NY!). ≡ *Ocotea acuminatissima* (Lundell) Rohwer

Cinnamomum amplifolium (Mez & Donnell-Smith) Kostermans, Reinwardtia 6: 20. 1961. ≡ *Phoebe amplifolia* Mez & Donnell-Smith, Bot. Gaz. (Crawfordsville) 19: 261. 1894. Type. Guatemala. El Quiché: El Jute. *Heyde & Lux 3033* (holotype, B!; isotypes, GH!, K!, NY!, US!). = *Ocotea* sp.

Cinnamomum areolatocostae (C.K. Allen) Kostermans, Reinwardtia 10: 441. 1988. ≡ *Phoebe areolatocostae* C. K. Allen, Mem. New York Bot. Gard. 10: 175. 1964. Type. Venezuela. Amazonas, Cerro de la Neblina, Río Yatua, *B. Maguire et al. 42085* (holotype, NY!; isotypes, F!, GH!, US!). ≡ *Persea areolatocostae* (C.K. Allen) van der Werff

Cinnamomum bahiense Vattimo, Rodriguésia 29(42): 128. 1977. Type. Brazil. Bahia: Itamaraju, Fazenda Palmeira. *Monteiro 23489* (holotype, RB!; isotype, RB!). = *Ocotea* sp.

Cinnamomum bourgeauvianum (Mez) Kostermans, Reinwardtia 6: 20. 1961. ≡ *Phoebe bourgeauviana* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 194. 1889. Type. Mexico. Veracruz: Córdoba. *Bourgeau 2234* (isosyntypes, B!, BM!, BR!, C!, F!, G!, GH!, MICH!, NY!, P!, US!). = *Ocotea helicterifolia* group.

Cinnamomum chinantecorum (Schultes) Kostermans, Reinwardtia 6: 20. 1961. ≡ *Phoebe chinantecorum* Schultes, Bot Mus. Leafl. 9: 170. 1941. Type. Mexico. Oaxaca: Choapam, San Juan Lalana. *Schultes & Reko 827* (holotype, ECON n.v.; isotypes, GH!, MICH!). = *Ocotea helicterifolia* group.

Cinnamomum corzoanum (Lundell) Kostermans, Reinwardtia 10: 442. 1988. ≡ *Phoebe corzoana* (Lundell) Lundell, Wrightia 5: 342. 1977. ≡ *Nectandra corzoana* Lundell, Wrightia 4: 102.

1969. Type. Mexico. Chiapas: Angel Albino Corzo, near the rancho viejo of the Finca Prusia, *A. Shilom 3560* (holotype, LL n.v.). = *Ocotea helicterifolia* group

Cinnamomum erectifolium (C.K. Allen) Kostermans, Reinwardtia 10: 442. 1988. ≡ *Phoebe erectifolia* C. K. Allen, Mem. New York Bot. Gard. 23: 860. 1972. Type. Venezuela. Bolívar: Meseta de Jáua. *Steyermark 97926* (holotype, NY!; isotype, VEN!). ≡ *Ocotea erectifolia* (C.K. Allen) van der Werff

Cinnamomum estrellensis (Meissner) Kostermans, Reinwardtia 6: 21. 1961. ≡ *Oreodaphne estrellensis* Meissner, in DC. Prodr. 15(1): 126. 1864. Type. Brazil. Serra Estrella. *Riedel s/n* (holotype, LE n.v.; isotypes, BR!, G!). = *Ocotea* sp.

Cinnamomum helicterifolium (Meissner) Kostermans, Reinwardtia 6: 21. 1961. ≡ *Oreodaphne helicterifolia* Meissner, in DC. Prodr. 15(1): 123. 1864. Type. Mexico. Chiapas: San Bartolo. *Linden 1641* (syntypes, A!, G!, P!). ≡ *Ocotea helicterifolia* (Meissner) Hemsley

Cinnamomum impressum (Meissner) Kostermans, Reinwardtia 10: 444. 1988. ≡ *Phoebe impressa* Meissner, in DC. Prodr. 15(1): 33. 1864. Type. Cayenne. *Patris s/n* (holotype, G-DC n.v.; isotype, NY!). ≡ *Aiouea impressa* (Meissner) Kostermans

Cinnamomum mayanum (Lundell) Kostermans, Reinwardtia 10: 446. 1988. ≡ *Phoebe mayana* Lundell, Amer. Midl. Nat. 29: 473. 1943. Type. Belize. Stann Creek: Baboon Stann Creek Valley. *Gentle 3187* (holotype, MICH!; isotypes, A!, F!, LL!, NY!). ≡ *Ocotea mayana* (Lundell) Lundell

Cinnamomum mezii Kostermans, Reinwardtia 6: 22. 1961. ≡ *Phoebe pauciflora* Mez, Bot. Jahrb. Syst. 17: 520. 1893. Type. Brazil. Rio de Janeiro: Monte Alto Macahé. *Glaziou 19792* (holotype, B? n.v.; isotypes, C!, P!). = *Ocotea* sp.

Cinnamomum mollicellum (Blake) Kostermans, Reinwardtia 6: 22. 1961. ≡ *Phoebe mollicella* Blake, Contr. Gray Herb. 52: 64. 1917. Type. Costa Rica. Copey. *Tonduz 11676* (holotype, GH!; isotypes, A!, BM!, GH!, MICH!, NY!, P!, US!). ≡ *Ocotea mollicella* (Blake) van der Werff

Cinnamomum nunesianum (Vattimo) Kostermans, Reinwardtia 10: 447. 1988. ≡ *Phoebe nunesiana* Vattimo, Arch. Jard. Bot. Rio de Janeiro 15: 140. 1957. Type. Brazil. Rio de Janeiro: Governador Portela, Monte Sinai. *Nunes 184* (holotype, RB!; isotype, RB!). = *Ocotea* sp.

Cinnamomum obtusatum (Lundell) Kostermans, Reinwardtia 6: 22. 1961. ≡ *Phoebe obtusata* Lundell, Contr. Univ. Michigan Herb. 6: 21. 1941. Type. Mexico. Chiapas: Buena Vista, near Escuintla. *Matuda 1887* (holotype, MICH!; isotypes, A!, LL!, NY!). = *Ocotea helicterifolia* group.

Cinnamomum pallescens (Mez) Kostermans, Reinwardtia 6: 22. 1961. ≡ *Phoebe pallescens* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 218. 1889. Type. Mexico. Veracruz: Orizaba. *Müller 90* (syntypes, A!, BR!, F!, K! NY!). = *Ocotea* sp.

Cinnamomum parvulum (Lundell) Kostermans, Reinwardtia 10: 448. 1988. ≡ *Phoebe parvula* Lundell, Wrightia 5: 343. 1977. Type. Mexico. Chiapas: Tenejapa, in Paraje Shohleh. *Ton 605* (holotype, LL!; isotypes, F!, MICH!, NY!). = *Ocotea* sp.

Cinnamomum patens (Meissner) Kostermans, Reinwardtia 6: 22. 1961.≡ *Mespilodaphne patens* Meissner, Vidensk. Meddel. Dansk. Naturhist. Foren. Kjobenhavn 174. 1870. Type. Brazil. Lagoa Santa. *Warming* (holotype, C!). = *Ocotea* sp.

Cinnamomum pittieri (Mez) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Phoebe pittieri* Mez, Bot.

Jahrb. Syst. 30, Beibl. 67: 16. 1901. Type. Costa Rica. Copey. *Tonduz 11893* (holotype, B n.v.; isotypes, BM!, US!). = *Ocotea pittieri* (Mez) van der Werff

Cinnamomum porphyrium (Grisebach) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Nectandra porphyria* Grisebach, Abh. Königl. Ges. Wiss. Göttingen 19: 144. 1874. Type. Argentina. Tucumán: near Siambón and La Cruz. *Hieronymus & Lorentz 48* (holotype, GOET? n.v.; isotype, G!). = *Ocotea* sp.

Cinnamomum psychotrioides (Humboldt, Bonpland & Kuntze) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Ocotea psychotrioides* Humboldt, Bonpland & Kuntze, in Kuntze. Nov. Gen. Sp. 2: 162.1817. Type. Mexico. Veracruz: Xalapa. *Humboldt & Bonpland 4434* (holotype, B n.v.; isotype, P!).

Cinnamomum salvinii (Mez) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Phoebe salvinii* (Mez) Lundell, Contr. Univ. Michigan Herb. 6: 23. 1941. ≡ *Ocotea salvinii* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 264. 1889. Type. Guatemala. Calderas: Volcán de Fuego. *Salvin s/n* (isosyntype, F!).

Cinnamomum savannae Vattimo, Rodriguésia 36(58): 42. 1984. Type. Brazil. Mato Grosso do Sul: near Zuzu. *Guimarães 1158* (holotype, RB!; isotype, RB!). = *Aiouea trinervis* Meissner

Cinnamomum semecarpifolium (Meissner) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Oreodaphne semecarpifolia* Meissner, in DC. Prodr. 15(1): 120. 1864. Type. Venezuela. Amazonas: by Río Casiquiare. *Spruce 3065* (holotype, G-DC n.v.; BM!, C!, G!, GH!). = *Ocotea* sp. (?)

Cinnamomum siltepecanum (Lundell) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Phoebe siltepecana* Lundell, Wrightia 1: 151. 1946. Type. Mexico. Chiapas: waterfall near Siltepec. *Matuda 5140* (holotype, LL!; isotype, LL!, NY!, US!). = *Ocotea acuminatissima* (Lundell)

Rohwer

Cinnamomum smithianum Kostermans, Reinwardtia 6: 23. 1961. ≡ *Phoebe smithii* C. K. Allen, J. Arnold Arbor. 26: 317. 1945. Type. Costa Rica. Alajuela: hills above Barranca Zarcero. *Smith 367* (holotype, F!; isotype, A!). = *Ocotea helicterifolia* group.

Cinnamomum subtriplinervium (Meissner) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Oreodaphne subtriplinervia* Meissner, in DC. Prodr. 15(1): 125. 1864. Type. Mexico. Veracruz: near Xalapa. Syntypes, *Linden 17* BR!, G!; *Galeotti 7061* BR!, G!, K!, P!). ≡ *Ocotea subtriplinervia* (Meissner) Hemsley. *Phoebe galeottiana* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 200. 1889 is an illegitimate name.

Cinnamomum tampicensis (Meissner) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Oreodaphne tampicensis* Meissner, in DC. Prodr. 15(1): 136. 1864. Type. Mexico. Tamaulipas: near Tampico. *Berlandier 132* (holotype, G-DC n.v.; isotypes, G!, P!). ≡ *Ocotea tampicensis* (Meissner) Hemsley

Cinnamomum valerianum (Standley) Kostermans, Reinwardtia 6: 24. 1961. ≡ *Phoebe valeriana* Standley, Publ. Field Mus. Nat. Hist., Bot. Ser. 18: 460. 1937. Type. Costa Rica. El Copey. *Tonduz 11746* (holotype, F!; isotypes, A!, BM!, G!, US!). ≡ *Ocotea valeriana* (Standley) W. Burger

Cinnamomum vanderwerffii Kostermans, Reinwardtia 10: 454. 1988. ≡ *Phoebe glabra* van der Werff, Ann. Missouri Bot. Gard. 74: 406. 1987. Type. Mexico. Oaxaca: Matías Romero. *Wendt et al. 4813* (holotype, MO!) ≡ *Ocotea henkwerffii* Lorea-Hernández, nom. nov. (*Ocotea glabra* van der Werff prevents the use of the specific epithet).

Excluded species in *Phoebe* not considered in *Cinnamomum* previously.

Phoebe angustata S. F. Blake, Contr. Gray Herb. n.s. 52: 63. 1917. Tyype. Mexico. Tamaulipas: near Victoria. *Palmer 80* (holotype, GH!; isotypes, A!, C!, F!, GH!, NY!, US!). = *Ocotea tampicensis* (Meissner) Hemsley

Phoebe belizensis Lundell, Contr. Univ. Michigan Herb. 6: 20. 1941. Type. Belize. Stann Creek: Stann Creek Valley, Mountain Cow Ridge. *Gentle 3304* (holotype, MICH!; isotypes, F!, LL!, NY!, US!). ≡ *Nectandra belizensis* (Lundell) C.K. Allen

Phoebe betazensis Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 192. 1889. Syntypes. Mexico. Oaxaca: Betaza. *Liebmann 23* (B!); Rincón *Galeotti 2885* (G!); San Pedro Nolasco, Talea. *Jürgensen 575* (G!). = *Ocotea helicterifolia* group.

Phoebe effusa var. *areolata* Meissner, in DC. Prodr. 15(1): 33. 1864. Type. Mexico. Veracruz: Xalapa. *Linden 19* (syntypes, G!, MICH!). = *Nectandra salicifolia* (Humboldt, Bonpland & Kunth) Nees

Phoebe gentlei (Lundell) Standley & Steyermark, Publ. Field Mus. Nat. Hist., Bot. ser. 23: 117. 1944. ≡ *Persea gentlei* Lundell, Contr. Univ. Michigan Herb. 6: 18. 1941. Type. Belize. Stann Creek: Stann Creek Valley, Mountain Cow Ridge. *Gentle 3288* (holotype, MICH n.v.; isotype, F!). = *Nectandra lundellii* C.K. Allen

Phoebe longicaudata Lundell, Bull. Torrey Bot. Club 64: 548. 1937. Type. Belize. El Cayo: near San Agustín, Mountain Pine Ridge. (syntypes, *Lundell 6833* MICH!, *Lundell 6757* MICH!, NY!, US!). ≡ *Nectandra longicaudata* (Lundell) C.K. Allen

Phoebe macrophylla Standley & Steyermark, Publ. Field Mus. Nat. Hist., Bot. Ser. 23: 116.

1944. Type. Guatemala. Alta Verapaz: southeast of Tactic. *Standley 91326* (holotype, F!; isotype, A!). ≡ *Ocotea standleyi* C.K. Allen

Phoebe nectandroides Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 194. 1889. ≡ *Oreodaphne mexicana* var. *subsessilis* Meissner, in DC. Prodr. 15(1): 118. 1864. Syntypes. Mexico. Oaxaca: San Pedro Nolasco. *Jürgensen 937* (BM!, G!), *Galeotti 7004* (A!, BR!, F!, G!, P!). = *Oreodaphne mexicana* var. *longipes* Meissner, in DC. Prodr. 15(1): 118. 1864. Veracruz: near Orizaba. *Botteri 1018* (A!, BM!, G!, P!). = *Ocotea helicterifolia* group.

Phoebe platyphylla Lundell, Contr. Univ. Michigan Herb. 6: 23. 1941. Type. Mexico. Chiapas: Finca Suiza, near Montecristo. *Matuda 1930* (holotype, MICH!; isotypes, A!, F!, LL!, NY!, US!). ≡ *Ocotea platyphylla* (Lundell) Rohwer

Phoebe purpurea Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 196. 1889. Type. Guatemala. Laraxquicam. *Tuerckheim 371* (syntypes, BM!, BR!, G!, P!). = *Ocotea helicterifolia* group.

Phoebe rivularis Vattimo, Rodriguésia 24: 254. 1964. Type. Brazil. Goiás: Distrito Federal, Brasília. *Heringer s/n* (holotype, RB!; isotype, RB!). = *Ocotea aciphylla* (Nees) Mez

Phoebe savannarum Standley & Steyermark, Publ. Field Mus. Nat. Hist., Bot. ser. 23: 118. 1944. Type. Guatemala. Alta Verapaz: between Cerro Chinajá at Sachaj and Sacacao. *Steyermark 45712* (holotype, F!; isotype, A!, LL!). = *Nectandra longicaudata* (Lundell) C.K. Allen

Phoebe saxchanalensis Lundell, Contr. Univ. Michigan Herb. 7: 14. 1942. Type. Mexico. Chiapas: Sierra Madre, Saxchanal. *Matuda 4311* (holotype, MICH!; isotypes, A!, F!, LL!, NY!). = *Ocotea acuminatisima* (Lundell) Rohwer

Phoebe steyermarkiana C. K. Allen, Mem. New York Bot. Gard. 10: 74. 1964. Type. Venezuela. Bolívar: Chimantá Massif, central section. *J. Steyermark & J. Wurdack 921* (holotype, NY!;

isotypes, F!, US!). ≡ *Ocotea julianii* van der Werff

Doubtful species.

The species included in this list represent material whose condition is too poor to make a reliable decision regarding the most likely genus or species they belong to. Except for *Laurus montana* (= *Phoebe montana*), all these taxa have pinninerved leaves. The group of species can be divided into several groups: 1) species whose ovary is wholly immersed in the hypanthium (*C. caratingae*, *C. microneurum*, *C. reticulifolium*, *C. riedelianum*), 2) species with fruit morphology similar to *Cinnamomum*, but flowers unknown (*C. mathewsii*, *C. filipes*), 3) species with no reliable type material at hand to be studied (*C. falcatum*, *C. mollis*, *C. stereophyllum*). Fruits for species in group 1 are not known, and although they have tepals rather erect at anthesis, and staminodes well developed, the ovary wholly immersed in the hypanthium reminds the condition found in *Aniba* and *Cryptocarya*. Species in group 2 could not be matched with flower material, and since there are a number of species in *Ocotea* in South America with similar general appearance, they were better left in this section. In the case of the two species included in group 3, type material could not be studied. For *C. falcatum* there are two collections with flowers (*Duss 3889*, *3661*) that were used by Mez to replace his original *O. falcata* into *Phoebe*, but checking the type material would be desirable to confirm his decision. For *C. mollis* there is a collection at F annotated as a possible isotype (*Haenke s/n*) but there is no way to be sure of this. This collection is very close morphologically to what in this study is called *C. velvetii*. A similar situation is found in *L. montana*; here, there is a Swartz collection without number at BM annotated with that name, but it is not sure that specimen is part of the original collection. No material comparable to *Phoebe stereophylla* was found found in the specimens studied.

Cinnamomum caratingae Vattimo, Rodriguésia 36: 41. 1984. Type. Brazil. Minas Gerais: Caratinga, Fazenda Silva. *Kuhlmann 27* (holotype, RB!; isotype, RB!).

Cinnamomum falcatum Howard, J. Arnold Arbor. 62: 46. 1981. ≡ *Ocotea falcata* Mez, Jahrb. Königl. Bot. Gard. Berlin 5: 388. 1889. Type. Guadeloupe. *Duchassaing s/n* (holotype, B n.v.). *Cinnamomum falcatifolium* Kostermans, Reinwardtia 6: 21. 1961, is an illegal name.

Cinnamomum filipes (Rusby) Kostermans, Reinwardtia 7: 461. 1969. ≡ *Persea filipes* Rusby, Bull. New York Bot. Gard. 6: 505. 1910. Type. Bolivia. Tumupasa. *Williams 352* (holotype, NY!). = *Ocotea* sp. (?)

Cinnamomum mathewsii (Mez) Kostermans, Reinwardtia 6: 21. 1961. ≡ *Phoebe mathewsii* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 217. 1889. Type. Peru. Chachapoyas. *Mathews s/n* (syntype, G!).

Cinnamomum microneurum (Meissner) Kostermans, Reinwardtia 6: 22. 1961. ≡ *Persea microneura* Meissner, in DC. Prodr. 15(1): 53. 1864. Type. Brazil. Corrego Seco. *Riedel s/n* (holotype, LE n.v.; isotypes, G!, K!).

Cinnamomum mollis (Mez) Kostermans, Reinwardtia 6: 22. 1961. ≡ *Phoebe mollis* Mez, Jahrb. Königl. Bot. Gart. Berlin 5: 192. 1889. Type. Mexico. Without specific locality. *Haenke s/n* (holotype, PR? n.v.; isotype, GOET? n.v.).

Laurus montana Swartz, Prodr. 65. 1788. Type. Jamaica. Without precise locality, *O. Swartz 1513* (holotype, S not seen; isotype, BM!(?)).

Phoebe montana Grisebach, Mem. Amer. Acad. Arts n.s. 8: 187. 1861.

Cinnamomum reticulifolium Kostermans, Reinwardtia 6: 23. 1961. ≡ *Phoebe reticulata* Mez, Arbeiten Königl. Bot. Gart. Breslau 1: 119. 1892. Type. Brazil. *Glaziou 18432* (holotype, B?

n.v.; isotypes, C!, K!).

Cinnamomum riedelianum Kostermans, Reinwardtia 6: 23. 1961. ≡ *Persea riedelii* Meissner, in DC. Prodr. 15(1): 54. 1864. Type. Brazil. Mandioca. *Riedel s/n* (holotype, LE n.v.; isotypes, G!, K!).

Cinnamomum stereophyllum (Meissner) Kostermans, Reinwardtia 6: 23. 1961. ≡ *Phoebe stereophylla* Meissner, in DC. Prodr. 15(1): 29. 1864. Type. Brazil. Without precise locality, *Sellow 390* (holotype BM?).

Cinnamomum trinerve (Lundell) Kostermans, Reinwardtia 10: 453. 1988. ≡ *Phoebe trinervis* Lundell, Phytologia 12: 245. 1965. Type. Guatemala. Petén: Tikal National Park. *Lundell 17591* (holotype, LL!; isotypes, F!, GH!, LL!, MO!, S!, US!).

II. Phylogenetic analysis.

Preliminaries.

Current classifications of the Lauraecae still maintain genera solely on the basis of particular combinations of characters despite their suspected polyphyletic condition (Burger, 1988; Rohwer et al., 1991; van der Werff, 1991a). This approach, although it allows a workable system of classification, prevents the recognition (for most of the cases) of phylogenetic relationships among the taxa.

Nees' (1836) monographic work defined the features on which taxonomists would later base their judgements for subdivision of the family. On page 18 of his Systema Laurinarum, Nees (1836) lists those characters that are important (in his point of view) for the classification of the Lauraceae. Notable among them are: number of sporangia in anthers, hypanthium covering or not covering the fruit, persistence of tepals in fruit, flower merosity, and type of inflorescence. It is interesting to note that although Nees often discussed (1836: 2, 10; in "Character Naturalis" and "Adversaria in Laurinarum Dispositionem" sections) and used (1836: 19-28; in "Affinitates Generum Laurinarum Naturales" section) the presence and extent of differentiation of staminodia of fourth whorl, and the extrorse condition of anthers in the third whorl to group species and genera in tribes, he did not list these characters as among the important ones for the subdivision of the family into natural groups.

Agreement on which of those characters used by Nees are the most inclusive and critical for elucidating evolutionary relationships within the Lauraceae has varied through time. Thus, to split the family into major groups, Meissner (1864) considered, after life form, inflorescence architecture as one of the most meaningful characters. This was a point of view with which

Bentham (1880) agreed and strengthened with the observation that this character correlates with the presence or absence of extrorse anthers in the third whorl. Pax (1889) thought that the number of sporangia in anthers was the most informative character for recognizing major groups within the family. Below the first or second division, characters such as anther dehiscence (introrse/extrorse), extent of hypanthium development in fruit, extent of development of fourth whorl staminodia, and number of sporangia in anthers, were used by these authors in different orders of importance to segregate smaller groups. Kostermans (1957) considered that the extent of hypanthium development in the fruit was the most meaningful character to understand the evolution of Lauraceae. Aware of the variation in number of anther sporangia and changes from fertile to sterile stamen whorls in closely related taxa, he underscored these features as some of the most important to identify major groups in the family; yet he used them to discern minor groups. Hutchinson (1964) argued that in spite of the work done during the first half of this century, it was better to follow earlier authors for concepts of taxa below family level; in general, his scheme matches Bentham's. Rohwer (1993a), in the most recent contribution dealing with the classification of Lauraceae, has attempted the combination of other kinds of information (anatomical, phytochemical, embryological) besides morphology in redefining the taxonomical units within the family. However, below the subfamily level he only indicated groups of genera and did not give them any systematic meaning on the grounds that, in his opinion, reticulate variation (of combination of characters) prevents the absolute delimitation of genera and suprageneric taxa.

In order to study the relationships between the group of species studied here and the species of *Cinnamomum* in the Old World, as well as the relationships among the species in the

New World, it was necessary first to assess how distinct *Cinnamomum* is as an evolutionary line in the family. As it seemed to me that considering simple match of general morphology of the group of species studied here to the morphology of the group of paleotropical ones was in some way too simplistic to accept congeneric relationship, I surveyed how reliable the combinations of characters (in particular those distinguishing *Cinnamomum*) are in order to advance hypotheses of evolutionary relationship within the family, specifically between the group of species studied here and other taxa. This survey analyzed not only character distribution among genera placed near *Cinnamomum* but throughout the family, since several characters that are found in this genus are shared with genera in other groups. Moreover, no cladistic analysis of the Lauraceae has been published, and it was considered a good idea to start this kind of study in the family. For this purpose I took as a baseline the latest taxonomic account (Rohwer, 1993a) for the recognition of genera (number and characters), complementing the descriptive information with other original works on anatomical (Richter, 1981) and phytochemical surveys across the family (Gottlieb, 1972), as well as personal observations.

Cladistics is chosen as the theoretical basis of the phylogenetic analysis because it enables us to infer evolutionary histories with a minimum of ambiguity. The methods and concepts developed in this philosophical approach of systematics have given to this branch of Biology its recognition as a true scientific field (Wiley, 1975, 1981). Among the major contributions of cladistics are: 1) the use of a method that allows reproducible results that can be reanalyzed by other authors, and 2) the possibility of elaborating classifications based on the recognition of monophyletic groups (Wiley et al., 1991). Central to cladistic methodology is parsimony; the principle that guides the process of analysis in order to minimize the

requirements for ad hoc hypotheses of homoplasy (Farris, 1983; Kluge, 1984). It is on this principle that programs of phylogenetic analysis like PAUP 3.1 (Swofford, 1990) are built. I used this program in my phylogenetic analysis of the genera in the Lauraceae and specifically for the species of *Cinnamomum*.

Outgroup selection.

The first step to evaluate the correlation of characters with the circumscription of taxa, required to do character polarization and advance hypotheses on the trends of transformation of character states. To do this, it was necessary to choose an appropiate outgroup for the family Lauraceae. Support for the selection procedure and designated outgroup is presented next.

Recent publications that advance ideas about the relationship of the Lauraceae with other taxa (Donoghue & Doyle, 1989; Loconte & Stevenson, 1991; Qiu et al., 1993) have shown that the Lauraceae mostly come together with the taxa that Cronquist (1981, 1988) included in his order Laurales. In one case (Loconte & Stevenson, 1991), the Lauraceae, Hernandiaceae and Gomortegaceae together form the sister group of the Monimiaceae. In the study of Qiu et al. (1993), the Lauraceae and Monimiaceae are sister taxa, while the pair Calycanthaceae - Idiospermaceae is the sister group of the Hernandiaceae. Both schemes suggest a clear trend of reduction in the number of floral parts leading to the general condition of few determined floral whorls found in the Lauraceae.The fact that Qiu et al. (1993) used the genus *Hedycarya* to represent the Monimiaceae, is really suggestive in the results they got, for this genus does not have two of the distinguishing features found in the Lauraceae, i.e. valvate pollen sacs and stamens with paired appendages at their base. This implies that, if these families are different,

these two morphological characters are not critical for distinguishing them. On the other hand, the distribution of these two characters within the Monimiaceae leads to the conclusion that they have evolved independently.

Thus, searching for the most suitable outgroup for the Lauraceae, the best choices to consider would be any taxa in the Monimiaceae that have anthers with valvate dehiscence or stamens with paired glands at their base. Evidence from comparative studies on the morphology of stamens in the Magnoliidae (Endress & Hufford, 1989) points to the fact that valvate dehiscence was apparently more common among primitive angiosperms and thus present in several primary independent phylogenetic lines. Meanwhile, stamens with paired appendages are restricted to some families in the Laurales, and the Chloranthaceae (if the structures are homologous). Thus, the limitation to choose an outgroup from the taxa with appendages at the base of the stamens would be advisable, namely the subfamilies Hortoniodeae, Atherospermatoideae, and the tribes Monimieae and Peumeae in the subfamily Monimioideae (sensu Philipson, 1993). Unfortunately, the phylogenetic relationships among these taxa are not resolved to a point that allows their use to define confidently ancestral states for characters in the Lauraceae. Thus, the outgroup algorithm suggested by Maddison et al. (1984) cannot be used for that purpose, except in few characters where the cladograms presented by Qiu et al. (1993) support the analysis at the family level. But other methods for character polarization can be applied (Watrous & Wheeler, 1981; Stuessy & Crisci, 1984).

Based on comparative morphology, Takhtajan (1980: 260) suggested the evolution of Lauraceae from primitive Monimiaceae; specifically, he mentions the genus *Hortonia* as the taxon that links both families. This genus has been considered, since Money et al.'s (1950) work,

to be at the base of the evolutionary line of the Monimiaceae. More recently that condition has been corroborated by other authors (Thorne, 1974; Endress, 1980). Indeed, the selection of *Hortonia* as an outgroup for the Lauraceae would leave as a possibility the existence of an ancestor which had the "predisposition of developing valvate dehiscence" (to use Endress & Hufford (1989) words), a feature that was lost in the line leading to *Hortonia* but retained and developed in some Monimiaceae and the Lauraceae. Thus, instead of taking another genus or a functional outgroup of several taxa of the Monimiaceae that present paired glands on the stamens or valvate anther dehiscence, *Hortonia* was prefered as the outgroup to polarize the characters in the Lauraceae, for that genus is the most conservative in characters among the Monimiaceae, and to reduce the chances of having many equivocal designations for ancestral character states.

Instead of including the outgroup in the analyses to root the cladograms, two different ways of "rooting" were accomplished: 1) insertion of a hypothetical ancestral taxon ("*Archaeodaphne*") elaborated by outgroup methodology, and 2) coding characters with *a priori* premises regarding sequence of transformation series.

Character argumentation.

Character evaluation to assess polarity should be based on homologous characters. The Lauraceae are commonly said to have a high level of homoplasy, but this may be the result of comparing characters that are not wholly homologous. Vegetative features are not hard to compare (homologize) between taxa, e.g. presence of leaves, phyllotaxy, venation pattern, stomate type, and vestiture. In other words, there is a narrower margin of making a mistake in deciding what a leaf is, and where it is placed on the stem, or to consider two leaves homologous

to each other, and compare their attributes, than when assessing homology in flowers. Floral characters are harder to evaluate for it is not easy to visualize which are the comparable morphological units. Since gynoecium and perianth vary little in the Lauraceae, but the androecium varies widely, the condition of this floral structure always has been used as an important character to recognize subordinate taxa within the family.

Total number of stamens and the number of sporangia per anther are often used as the characters to consider from the androecium, but the fact that individual whorls vary independently supports the idea that each staminal whorl can be taken as a separate morphological unit. In doing this, the number of sporangia becomes an attribute for each whorl of stamens, as well as it does the transformation of stamens into staminodes or their elimination. Even more, sporangia themselves can be considered characters, and their position on the anther and dehiscence be the attributes. This is a better way to evaluate possible phylogenetic lines within the family, because comparable units are not mixed.

Floral characters in *Hortonia* are in general easy to homologize and compare with those of the Lauraceae, except for their phyllotaxy. In *Hortonia* flowers, there are up to 12 stamens arranged in a spiral way. The same occurs in the Atherospermateae and Laurelieae (with few to 12 stamens), and in the other groups of the Monimiaceae with paired glands on the stamens (Monimieae and Peumeae, which have numerous stamens). There are no identifiable whorls to compare with the Lauraceae. Therefore, the change from spiral to whorled phyllotaxy has to be assumed to have happened in the ancestor of the Lauraceae.

Evaluation of trends of variation in fruit characters is not difficult in terms of understanding what the morphological units are, but rather in determining the primitive (original)

condition. Fruits have little variation in the Lauraceae, while accessory parts do vary widely. Two critical points to decide here are whether deciduous tepals are a primitive condition, and whether or not accrescent hypanthium in fruit is a primitive condition. In *Hortonia*, fruits are drupes borne by a scarcely thickened receptacle having on its rim the withered sepals. Receptacles for most of the other groups in the Monimiaceae surround the fruits and split at maturity, while in others the upper part is shed as a calyptra.

Characters used for the cladistic analysis of the genera and their states are commented on next. In principle, these characters are those that have been traditionally used to separate the genera in the family Lauraceae, features for which there was an interest to test their potential power in showing relationships among taxa in the context of an evolutionary frame.

1. *Phyllotaxy*. This is one of the few characters that can be analyzed by the outgroup algorithm proposed by Maddison et al. (1984) at the family level, using cladograms in figs. 2, 3 and 4 from Qiu et al. (1993) as reference for outgroup phylogeny. Then, opposite leaves is considered the ancestral condition for leaf arrangement. Trend of change to other conditions is left unordered. **0**, opposite leaves; **1**, alternate leaves; **2**, "fascicled" leaves.

2. *Venation pattern*. Triplinerved leaves are rather typical in several genera of the Lauraceae, but they also occur at low frequencies within some of the typically pinninerved genera. In *Hortonia* (Monimiaceae), one species out of three is also with triplinerved leaves. However, the decision on character polarization is based on the proportion of taxa with one or the other condition in venation pattern (Watrous & Wheeler, 1981); thus pinninerved leaves are considered plesiomorphic. **0**, leaves pinninerved; **1**, leaves triplinerved.

3. *Integrity of leaves*. Lobed leaves is a very rare condition within the Lauraceae, and

although *Hortonia* recently has been reported as sometimes having toothed leaves, no record of lobed leaves exists for this genus or any other closely related to it. Thus, entire leaves are considered the ancestral state. **0**, entire leaves; **1**, lobed leaves.

4. *Persistence of leaves*. At first this character was considered the product of enviromental adaptation, but the fact that several taxa from temperate regions do not present deciduous leaves suggests the likelihood of this being a feature developed in one or few phyletic lines. Taxa with perennial leaves (with this is meant that leaves and flowers are present at the same time) outnumber those with deciduous leaves. The three species of *Hortonia* have perennial leaves. **0**, leaves perennial; **1**, leaves deciduous.

5. *Domatia in leaves*. These specialized areas of the lamina are found only in some genera of the Lauraceae. They are not present in *Hortonia*. **0**, domatia absent; **1**, domatia present.

6. *Inflorescence protection*. Based on figs. 2, 3 and 4 from Qiu et al. (1993), this character can be polarized following the method proposed by Maddison et al. (1984). This indicates that inflorescences without bracts are the ancestral condition for this character. **0**, bracts absent; **1**, bracts present.

7. *Inflorescence architecture*. This character is rather difficult to polarize. Cymose-paniculate inflorescences, as well as racemose ones, are found both in the Monimiaceae and the Lauraceae. Inflorescences in two of the three species of *Hortonia* (*H. angustifolia* and *H. floribunda*), present at least partially cymose-paniculate inflorescences. Based on this evidence cymose-paniculate architecture is considered plesiomorphic. **0**, cymose-paniculate; **1**, botryoid or racemose; **2**, umbellate.

8. *Floral merosity*. As was mentioned above, recent surveys about the phylogenetic

relationships within the Magnoliidae show a trend of reduction of floral parts and the change from spiral to whorled phyllotaxis of perianth, stamens and carpels. Spiral phyllotaxis is present in *Hortonia*, but such condition is not known among the Lauraceae. Furthermore, in the other taxa of the Monimiaceae closely related to that genus both spiral and whorled phyllotaxis is present. This suggest that the ancestor to the Lauraceae might be somewhere in between *Hortonia* and its closest relatives in the Atherospermatoideae or the Monimioidae. In any case, an original condition of fixed whorled phyllotaxis for the ingroup is assumed. **0**, flowers trimerous; **1**, flowers dimerous or tetramerous.

9. *Flower sex*. Both perfect and unisexual flowers occur in the Lauraceae, but the perfect condition is most common. Perfect flowers have usually been considered to be the plesiomorphic condition for sex distribution within the Magnoliidae, and the Lauraceae are not the exception. Besides, *Hortonia* is with perfect flowers too. **0**, flowers perfect; **1**, flowers unisexual.

10. *Position of floral parts with respect to pistil*. The hypanthium is taken here as receptacular in origin. Thus, position of floral units is actually the one that is observed. The hypanthium, either shallow or deep, is widely present within the Monimiaceae (*Hortonia* has it) as well as in the Lauraceae, and then the perigynous condition of the perianth and the stamens is considered plesiomorphic. The application of the outgroup algorithm suggested by Maddison et al. (1984) to the phylogenetic trees presented in Qiu et al. (1993) supports this conclusion. The changes to hypogynous or epigynous conditions could have occured several times, and it is not sure that shifts from hypogynous to epigynous position, or viceversa, can be overruled to have happened. So, changes between states are unordered. **0**, perianth and stamens hypogynous; **1**, perianth and stamens perigynous; **2**, perianth and stamens epigynous.

11. *Direction of tepals at anthesis*. In all three species of *Hortonia* (as well as in most closely related genera) tepals are spreading away from flower axis, and this is considered the plesiomorphic state. Reversal from erect tepals to the original condition is, however, regarded as possible. **0**, spreading; **1**, erect.

12. *Relative size between perianth whorls*. Perianth in *Hortonia* gradually changes from the external smaller sepaloid tepals to the larger internal petaloid tepals. Yet, most of the inner tepals are about the same size. But correspondence between the spiral tepals of *Hortonia* and the whorled tepals in the Lauraceae is not easy to solve. For this analysis, inner tepals of *Hortonia* are homologized to tepals in the Lauraceae, states are unordered. **0**, tepals same size; **1**, tepals different size.

13. *Hairs on inner floral parts*. At first the type of pubescence is included because of its usefulness in separating *Cinnamomum* species. In addition, flower internal pubescence is particularly considered of importance from its suggested correlations with other characters (Rohwer, 1994). *Hortonia* has only sericeous hairs at the base of stamens and hypanthium. States are left unordered. **0**, ± appressed sericeous; **1**, "papillose"; **2**, absent.

14. *Supernumerary whorls of stamens (5 or more)*. Using the outgroup algorithm (Maddison et al., 1984) on the cladograms presented by Qiu et al. (1993) one reaches the result that androecium presents also the trend of reduction observed in other floral elements in the Magnoliidae. The number five is set because the usual condition in the Lauraceae is three whorls of stamens (or four, if one considers the staminodial whorl as the fourth). Supernumerary whorls of stamens are common within the Monimiaceae, and just a few cases are known in the Lauraceae. *Hortonia* does not have, strictly speaking, five or more whorls of stamens, but it does

have several staminodes (Endress, 1980), which added to the number of stamens, at least in some flowers, point to the presence of a fifth whorl lost during evolution. Based on this evidence supernumerary whorls in the ingroup are considered plesiomorphic. **0**, supernumerary whorls of stamens present; **1**, supernumerary whorls of stamens absent.

15. *Condition of fourth whorl stamens*. The transformations in the stamens of the fourth whorl have usually been considered important for recognizing groups within the Lauraceae. One of these modifications is their change into staminodes. The degree of reduction in their structure up to their final elimination form another set of useful characters. Once the stamens are sterile they don't turn back to the fertile condition. Therefore, this change is taken as irreversible. But the steps between the extremes may not take place necessarily in an ordered way, as the several combinations of fertile stamens with different transformation states of the fourth whorl suggest within the genera of Lauraceae. In other words, the change from fertile to sterile is considered equally possible as the direct change from fertile to absent. This character is coded following the previous comments (see figure 20 for explanation). **0**, fertile; **1**, staminode differentiated; **2**, staminode undifferentated; **3**, absent.

16. *Condition of inner sporangia, fourth whorl stamen*. Orientation of the sporangia is particularly hard to decipher in evolutionary terms. Introrse and extrorse condition are found among different taxa in the Magnoliideae. The same situation is present within the Monimiaceae. *Hortonia* has extrorse anthers, but this condition is rather uncommon in the Lauraceae. The decision of considering extrorse dehiscence plesiomorphic was complemented with a second option where introrse dehiscence is plesiomorphic. Changes from latrorse to either extrorse or introrse states, or vice versa, are regarded as equally possible. Even the direct change from

extrorse to introrse, and vice versa, is viewed a very likely phenomenon as the case of the outer sporangia in the third whorl stamens imply. Apical dehiscence is taken as an extreme of specialization without return. As in the case considering whole anther transformation, once a sporangium is sterile it cannot go back to the fertile condition. Comments for this character are also valid for the rest of characters dealing with sporangia (down to number 23). Coding for this character and for characters down to number 23 is shown in figure 20. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

17. *Condition of inner sporangia, third whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

18. *Condition of inner sporangia, second whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

19. *Condition of inner sporangia, first whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

20. *Condition of outer sporangia, fourth whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

21. *Condition of outer sporangia, third whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

22. *Condition of outer sporangia, second whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

23. *Condition of outer sporangia, first whorl stamen*. See comments in character 16. **0**, introrse; **1**, latrorse; **2**, extrorse; **3**, apical; **4**, absent.

24. *Glands of fourth whorl stamens*. Paired appendages (glands) at the base of stamens is

considered plesiomorphic for the Lauraceae. In the Monimiaceae, all the taxa that have paired glands do bear them on all stamens, including the staminodia (usually present). *Hortonia* displays the same condition. **0**, glands present; **1**, glands absent.

25. *Glands of third whorl stamens*. See comment in character 24. **0**, present; **1**, absent.

26. *Glands of second whorl stamens*. See comment in character 24. **0**, present; **1**, absent.

27. *Glands of first whorl stamens*. See comment in character 24. **0**, present; **1**, absent.

28. *Relative position of sporangia on anthers*. By position of sporangia is meant the arrangement of the original pair of these structures in an anther half (a theca). Collateral sporangia are found in all the close outgroups to the Lauraceae (as viewed in Qiu et al., 1993), although there are some also with single sporangia, including some Monimiaceae. *Hortonia* presents the condition of collateral sporangia. Therefore, collateral sporangia are considered plesiomorphic. The trend followed toward the reduction of one of the two original sporangia is considered irreversible. Recent data (Rohwer, 1994; pers. obs.) suggest that single sporangia are lost only when they attain the overlapped condition. No evidence of return from overlapped to collateral condition has been observed or reported. **0**, sporangia collateral; **1**, sporangia shifted; **2**, sporangia overlapped; **3**, sporangia single.

29. *Persistence of tepals in fruit*. Tepals in the Monimiaceae are found to be either persistent or deciduous, just as in the Lauraceae. In *Hortonia* the tepals are persistent, although most of them rather withered. The external ones do seem to be still alive when fruit is developed. Based on this circumstance, persistence of tepals is considered the plesiomorphic state for this character. **0**, persistent, at least partially; **1**, not persistent.

30. *Hypanthium in fruit*. Contrary to what Kostermans (1957) believed, states of this

character are hard to align into an evolutionary sequence. This is because the hypanthium may grow or just broaden as fruit develops, and then the height of the hypanthium with respect to the fruit can be reached by two different processes. Besides, as mentioned above, perigynous flowers seem to be the original condition in the Lauraceae, and the abscence of the hypanthium in the fruit may be also attained by two different ways: reduction or dehiscence (both recorded in the Lauraceae). In the Monimiaceae many taxa present a large hypanthium that splits out at maturity, but usually it is already large and concave in the flower. *Hortonia* has a non accrescent hypanthium in the fruit. Even so, variation is so broad in the Lauraceae that it is preferred to leave the morphological sequence of the hypanthium as is and unordered. **0**, hypanthium absent; **1**, hypanthium present, not accrescent; **2**, hypanthium covering up to 2/3 of fruit; **3**, fruit enclosed in the hypanthium.

31. *Vessel perforations*. In this case, polarization and character state sequence is strengthened by the trend observed in the wide comparison compiled for the dicotyledons as a whole (Chalk, 1983a). *Hortonia*, however, has vessel elements only with scalariform perforations. The trend suggested here for the present character seems to be irreversible. **0**, simple only; **1**, simple and scalariform.

32. *Fibers in wood*. Although no recognizable trend for this character is found for the angiosperms as a whole, polarization is based on the fact that *Hortonia* has wood fibers without septa (Money et al., 1950). Character states are unordered. **0**, not septate; **1**, septate.

33. *Axial parenchyma*. Character polarization and state sequence is defined on the basis that *Hortonia*'s axial parenchyma is of the diffuse-in-aggregates type (Money et al., 1950). This arrangement belongs to the simple apotracheal type, in contrast to the more complex paratracheal type found in the Lauraceae. The general comparison survey within the dicotyledons (Chalk,

1983b) supports the state sequence. Trend is considered irreversible. **0**, scanty - unilateral; **1**, vasicentric - confluent; **2**, aliform - confluent.

34. *Fibers in secondary phloem*. Information available for interpretation of this character is ambiguous (Esau, 1983). Character states are just indicated. **0**, present; **1**, absent.

35. *Alkaloids*. Owed to the scarce information about presence and diversity of alkaloids in the Lauraecae, the elementary dichotomy presence-absence was chosen to incorporate these data in the analysis. As these substances can be synthetized along different biochemical pathways (Hegnauer, 1963), no attempt is advanced for polarization. States are just indicated. **0**, present; **1**, absent.

36. *Arylpropanoids*. These chemicals are considered in the analysis for it has been suggested that they are restricted to few phylogenetic lines within the Lauraceae (Gottlieb, 1972). No ancestral state is suggested. **0**, present; **1**, absent.

As was said earlier, many genera in the Lauraceae are not sharply delimited. Genera normally contain a core of species that present consistently certain combination of characters and some peripheral ones that to a lesser degree fit the particular character syndrome for another given genus (or genera). Therefore, in order to make this first attempt of cladistic analysis of the family simpler, character states were coded for the genera according to what was regarded the general (most common) condition based on the literature or from direct observations of herbarium material. In other words, polymorphic characters were in principle omitted by selecting one state condition. Some argumentation could be presented against this decision, for it prevents the exploration of possible connections between the genera when that information from

polymorphic characters is not incorporated into the analysis. However, I considered that the record of polymorphic characters within genera can be the result of a taxonomy based on general resemblance, and characters of unusual species in several genera may not represent evolutionary lines within those genera but offshoots from other genera that come to resemble other taxa. Then, the insertion of these data would produce false variation for character states within genera in the analysis. That is why initially a comparison of core character syndromes for the genera was preferred. In any case, the data matrix (figure 19) devised for this study can be used to assess in the future other combinations of characters for the genera, or subdivide the genera into as many different "natural groups" as can be recognized within them. A summary of character status is presented in figure 20.

Results.

Effectiveness of cladograms may be diminished since the analyses were stopped prematurely. As can be seen in the data matrix (figure 19), the amount of characters is low compared to the number of taxa, a condition which diminishes the posssibility of getting an easy solution to the cladograms. It was expected that the characters with several states would compensate in some way for this lack of characters in the analyses, yet this did not happen. In the case of the analysis without restrictions on character states changes, the memory allocated in the program was insufficient to hold all the equally parsimonious trees produced. For the analyses with restrictions on character changes time necessary to compute all equally parsimonious trees was extremely long, and the search was stopped after several days of computer work on each analysis. Strict consensus trees were computed for all the analyses, but terminal taxa mostly were

collapsed; therefore majority rule trees are reported to visualize distinctiveness of groups of genera. Even with this probable source of drawbacks, it was worth to go ahead and point to some elements of interest from these strictly preliminary surveys realized.

The cladogram obtained entering character data without any restriction, i.e. all character states unordered, is shown in figure 21. Figure 22 shows the majority rule consensus tree with restrictions imposed as commented in the charater state polarization section. This was a second run for the analysis of genera. A third run was effected including the hypothetical ancestor "Archaeodaphne" coding its characters 16 to 23 with **0** (introrse sporangia; see figure 20). Figure 23 shows the corresponding majority rule consensus cladogram. Subdivision of the genus *Cinnamomum* into four groups representing the two sections recognized in the paleotropics, and the two morphological groups identified in the neotropics were coded for a fourth run of the analysis. The majority rule consensus tree for this evaluation is shown in figure 24. For the last two analyses characters were also coded with restrictions as explained above.

It is important to stress that the way characters were defined and coded supplies some information regarding the evolutionary relationships among the genera in the Lauraceae. Nevertheless, placement of the different genera in the final outcome could be affected by two sources of ambiguity: lack of information for several characters in some genera, and interpretation of certain information regarding particular characters across the whole family.

Discussion and conclusions.

Discussion of results are basically referred to Rohwer's ideas on the subdivision of the family (Rohwer, 1993a). The first interesting issue is the separation at the bottom of the

LAURACEAE 1		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
1	ACTINODAPHNE	1	0	0	0	0	1	1	0	1	?	0	0	2	1	3	4	0	0	0	4	0	0	0	1	0	1	1	2	1	1	1	0	0	0	0	1
2	AIOUEA	1	0	0	0	?	0	0	0	0	1	1	0	?	1	2	4	4	4	4	4	2	0	0	1	0	1	1	3	1	1	1	1	0	0	?	?
3	ALSEODAPHNE	1	0	0	0	0	0	1	0	0	0	0	1	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	2	1	1	0	1	0	0	0	1
4	ANAUERIA	0	0	0	0	0	0	1	0	0	0	1	1	0	1	2	4	4	?	?	4	4	?	?	1	1	1	1	3	1	1	0	0	2	?	0	1
5	ANIBA	1	0	0	0	0	0	0	0	0	2	1	0	?	1	2	4	?	?	?	4	?	?	?	1	0	1	1	3	1	2	0	1	0	1	0	0
6	APOLLONIAS	1	0	0	?	0	0	0	0	0	0	?	0	?	1	1	4	4	4	4	4	2	0	0	1	0	1	1	3	0	1	0	1	0	0	1	1
7	ASPIDOSTEMON	0	0	0	?	0	0	0	0	0	2	?	0	?	1	2	4	4	?	?	4	4	?	?	1	0	1	1	3	0	3	?	?	?	?	?	?
8	BEILSCHMIEDIA	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	4	4	4	4	4	2	0	0	1	0	1	1	3	1	0	0	0	2	1	0	1
9	BRASSIODENDRON	1	0	0	0	0	0	0	0	0	1	1	0	1	1	3	4	4	1	1	4	4	1	1	1	1	0	0	0	1	0	?	?	?	?	?	?
10	CARYODAPHNOPSIS	0	1	0	0	0	0	0	0	0	0	1	1	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	1	1	0	0	1	0	0	?	?
11	CASSYTHA	1	?	?	?	0	0	1	0	0	1	?	1	?	1	2	4	4	4	4	4	2	0	0	1	0	1	1	3	0	3	?	?	?	?	0	1
12	CHLOROCARDIUM	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	1	1	1	2	2	2	2	0	0	0	0	2	1	2	?	?	?	?	?	?
13	CINNADENIA	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	?	?	?	?	?	?
14	CINNAMOMUM	0	1	0	0	1	0	0	0	0	1	1	0	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	2	0	1	?	0	1	0	0	0
15	CRYPTOCARYA	1	0	0	?	0	0	0	0	0	2	?	0	?	1	1	4	4	4	4	4	2	0	0	1	0	1	1	3	1	3	0	0	0	1	0	1
16	DAHLGRENODENDRO	0	0	0	0	0	0	1	0	0	2	1	0	2	1	1	4	4	4	4	4	2	0	0	1	0	1	1	3	0	3	?	?	?	?	?	?
17	DEHAASIA	1	0	0	0	0	0	0	0	0	1	1	1	0	1	2	4	4	4	4	4	2	0	0	1	0	1	1	3	1	1	?	1	0	0	0	1
18	DICYPELLIUM	1	0	0	0	0	0	1	0	0	1	0	0	2	1	3	4	1	0	4	4	1	0	4	1	0	1	1	1	0	2	0	1	1	0	1	0
19	DODECADENIA	1	0	0	0	0	1	2	0	1	0	?	0	?	0	0	0	0	0	0	1	1	1	1	0	0	1	1	2	1	1	?	?	?	?	0	1
20	ENDIANDRA	1	0	0	0	0	0	0	0	0	1	0	0	1	1	2	4	2	4	4	4	4	4	4	1	0	1	1	0	1	0	0	0	1	1	?	?
21	ENDLICHERIA	1	0	0	?	0	0	0	0	1	1	?	0	?	1	3	4	4	4	4	4	2	0	0	1	0	1	1	3	1	2	1	1	0	0	?	?
22	EUSIDEROXYLON	1	0	0	0	0	0	0	0	0	1	0	0	1	1	2	4	0	4	4	4	1	4	4	1	0	0	0	0	1	3	0	0	2	0	1	0
23	GAMANTHERA	1	0	0	0	0	0	0	0	1	1	1	1	2	1	3	4	4	4	4	4	3	4	4	1	1	1	1	3	0	2	?	?	?	?	?	?
24	HEXAPORA	1	0	0	?	0	0	1	0	0	0	?	1	?	1	2	4	4	4	4	4	4	2	2	1	1	1	1	3	0	1	?	?	?	?	?	?
25	HYPODAPHNIS	1	0	0	0	1	0	0	0	1	2	0	0	0	1	3	4	2	0	0	4	2	0	0	1	0	1	1	0	1	3	0	0	2	0	?	?
26	ITEADAPHNE	1	0	0	?	0	1	1	0	1	0	?	0	?	1	2	4	4	4	4	4	1	0	0	1	0	1	1	3	1	1	?	?	?	?	0	1
27	LAURUS	1	0	0	0	1	1	2	1	1	0	0	0	0	0	0	4	4	4	4	4	0	0	0	0	0	0	1	1	3	1	1	1	0	0	0	1
28	LICARIA	1	0	0	0	0	0	0	0	0	1	1	0	?	1	3	4	4	4	4	4	2	4	4	1	0	1	1	3	1	2	0	1	0	1	1	0
29	LINDERA	1	0	0	1	0	1	2	0	1	0	?	0	?	1	3	4	4	4	4	4	0	0	0	0	0	1	1	3	1	1	1	0	0	0	0	1
30	LITSEA	1	0	0	0	0	1	2	0	1	0	?	0	?	1	3	4	0	0	0	4	0	0	0	0	0	1	1	2	1	2	?	?	?	0	0	1
31	MEZILAURUS	2	0	0	0	0	0	1	0	0	1	1	0	1	1	3	4	4	4	4	4	2	4	4	1	1	1	1	3	1	1	0	1	0	1	?	?
32	MOCINNODAPHNE	1	1	0	0	1	0	0	0	0	1	1	0	2	1	1	4	4	4	4	4	2	4	4	1	0	1	1	3	0	1	?	?	?	?	?	?
33	NECTANDRA	1	0	0	0	0	0	0	0	0	1	0	0	1	1	2	4	1	0	0	4	2	0	0	1	0	1	1	1	1	2	0	1	0	0	0	1
34	NEOCINNAMOMUM	1	1	0	0	1	0	2	0	0	1	0	0	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	0	0	1	0	1	0	1	?	?
35	NEOLITSEA	1	1	0	0	0	1	2	1	1	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2	1	2	1	0	0	0	0	1
36	NOTHAPHOEBE	1	0	0	0	0	0	0	0	0	0	0	1	0	1	2	4	2	0	0	4	2	0	0	1	0	1	1	2	0	1	0	1	0	0	0	1
37	OCOTEA	1	0	0	0	0	0	0	0	0	1	?	0	?	1	2	4	1	0	0	4	2	0	0	1	0	1	1	2	1	2	0	1	0	0	0	0
38	PARAIA	1	0	0	0	0	0	1	0	0	1	1	0	2	1	2	4	1	0	0	4	1	0	0	1	0	1	1	1	0	2	?	?	?	?	?	?
39	PARASASSAFRAS	1	1	1	1	?	1	2	0	1	0	?	1	?	1	3	4	0	0	0	4	0	0	0	1	0	1	1	2	0	1	?	?	?	?	?	?
40	PERSEA	1	0	0	0	0	0	0	0	0	0	?	0	?	1	1	4	2	0	0	4	2	0	0	1	0	1	1	2	0	1	?	?	?	0	1	1
41	PHOEBE	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	4	2	0	0	4	2	0	0	1	0	1	1	2	0	1	?	1	0	0	0	1
42	PHYLLOSTEMONODA	1	0	0	0	0	0	1	0	0	1	0	0	2	1	3	4	1	0	4	4	4	4	4	1	0	0	1	3	0	1	?	?	?	?	?	?
43	PLEUROTHYRIUM	1	0	0	0	0	0	0	0	0	1	0	0	?	1	2	4	0	0	0	4	2	2	2	1	0	1	1	1	1	2	1	1	0	0	?	?
44	POTAMEIA	1	0	0	0	0	0	0	1	0	1	1	0	0	1	2	4	4	4	4	4	4	4	0	0	1	0	1	1	3	0	1	0	0	1	?	?
45	POTOXYLON	1	0	0	0	0	0	1	0	0	1	1	0	1	1	1	4	2	0	0	4	2	0	0	1	0	1	1	0	1	3	?	?	?	?	?	?
46	POVEDADAPHNE	1	0	0	0	1	0	0	0	0	1	1	0	2	1	3	4	3	3	3	4	3	3	3	1	0	1	1	0	1	1	?	?	?	?	?	?
47	RAVENSARA	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	4	4	4	4	4	2	0	0	1	0	1	1	3	0	3	0	0	0	?	?	?
48	RHODOSTEMONODAI	1	0	0	0	0	0	0	0	1	1	?	0	?	1	3	4	2	0	0	4	2	0	0	1	0	1	1	0	1	2	?	?	?	?	?	?
49	SASSAFRAS	1	1	1	1	0	1	1	0	1	0	1	0	2	1	2	4	0	0	0	4	0	0	0	1	0	1	1	2	0	1	0	0	0	0	1	0
50	SYSTEMONODAPHNI	1	0	0	0	0	0	0	0	0	1	0	0	0	1	?	4	0	0	0	4	0	0	0	1	0	1	1	1	0	2	0	1	1	0	?	?
51	UMBELLULARIA	1	0	0	0	0	1	2	0	0	0	1	0	2	1	2	4	1	0	0	4	2	0	0	1	0	1	1	2	0	1	0	1	1	0	1	0
52	URBANODENDRON	1	0	0	0	0	0	0	0	0	1	1	0	0	1	2	4	1	0	0	4	1	0	0	1	0	0	0	1	0	2	0	1	1	0	?	?
53	WILLIAMODENDRON	2	0	0	0	0	0	0	0	0	1	1	1	2	1	2	4	3	4	4	4	3	4	4	1	1	1	1	0	0	1	?	?	?	?	?	?

Figure 19. Data matrix used for the phylogenetic analysis of the genera in the family Lauraceae.

Character	Type
1	Unord
2	Unord
3	Unord
4	Unord
5	Unord
6	Unord
7	Ord
8	Unord
9	Irrev(Up)
10	Unord
11	Unord
12	Unord
13	Unord
14	Irrev(Up)
15	Laura 1
16	Laura 2
17	Laura 2
18	Laura 2
19	Laura 2
20	Laura 2
21	Laura 2
22	Laura 2
23	Laura 2
24	Irrev(Up)
25	Irrev(Up)
26	Irrev(Up)
27	Irrev(Up)
28	Irrev(Up)
29	Unord
30	Unord
31	Irrev(Up)
32	Unord
33	Irrev(Up)
34	Unord
35	Unord
36	Unord

Stepmatrix 'Laura 1':

	TO: 0	1	2	3
FROM: 0	-	1	1	1
1	inf	-	1	1
2	inf	inf	-	1
3	inf	inf	inf	-

Stepmatrix 'Laura 2':

	TO: 0	1	2	3	4
FROM: 0	-	1	1	1	1
1	1	-	1	1	1
2	1	1	-	1	1
3	inf	inf	inf	-	1
4	inf	inf	inf	inf	-

Character states for current ancestor: "Archaeodaphne1"

```
                                  11111111112222222222333333333
                        123456789012345678901234567890123456
                        ------------------------------------
Archaeodaphne1          000000000??0000000000000000?100???
```

CINNAMOMUM(1)	1	0	0	0	1	0	0	0	0	1	1	0	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	2	0	1	?	0	1	0	0	0
CINNAMOMUM(2)	0	1	0	0	0	0	0	0	0	1	1	0	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	2	0	1	?	?	?	?	?	?
CINNAMOMUM(3)	1	1	0	0	1	0	0	0	0	1	1	0	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	2	0	1	?	?	?	?	?	?
CINNAMOMUM(4)	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	4	1	0	0	4	2	0	0	1	0	1	1	2	0	1	?	?	?	?	?	?

Figure 20. Complementary data used for the phylogenetic analysis of the genera in the family Lauraceae. **A**. Character types. **B**. Stepmatrices used in characters "Laura 1", and "Laura 2". **C**. Character coding for the hypothetical ancestor "Archaeodaphne". **D**. Character coding of the four groups of species of *Cinnamomum* (see text for explanation).

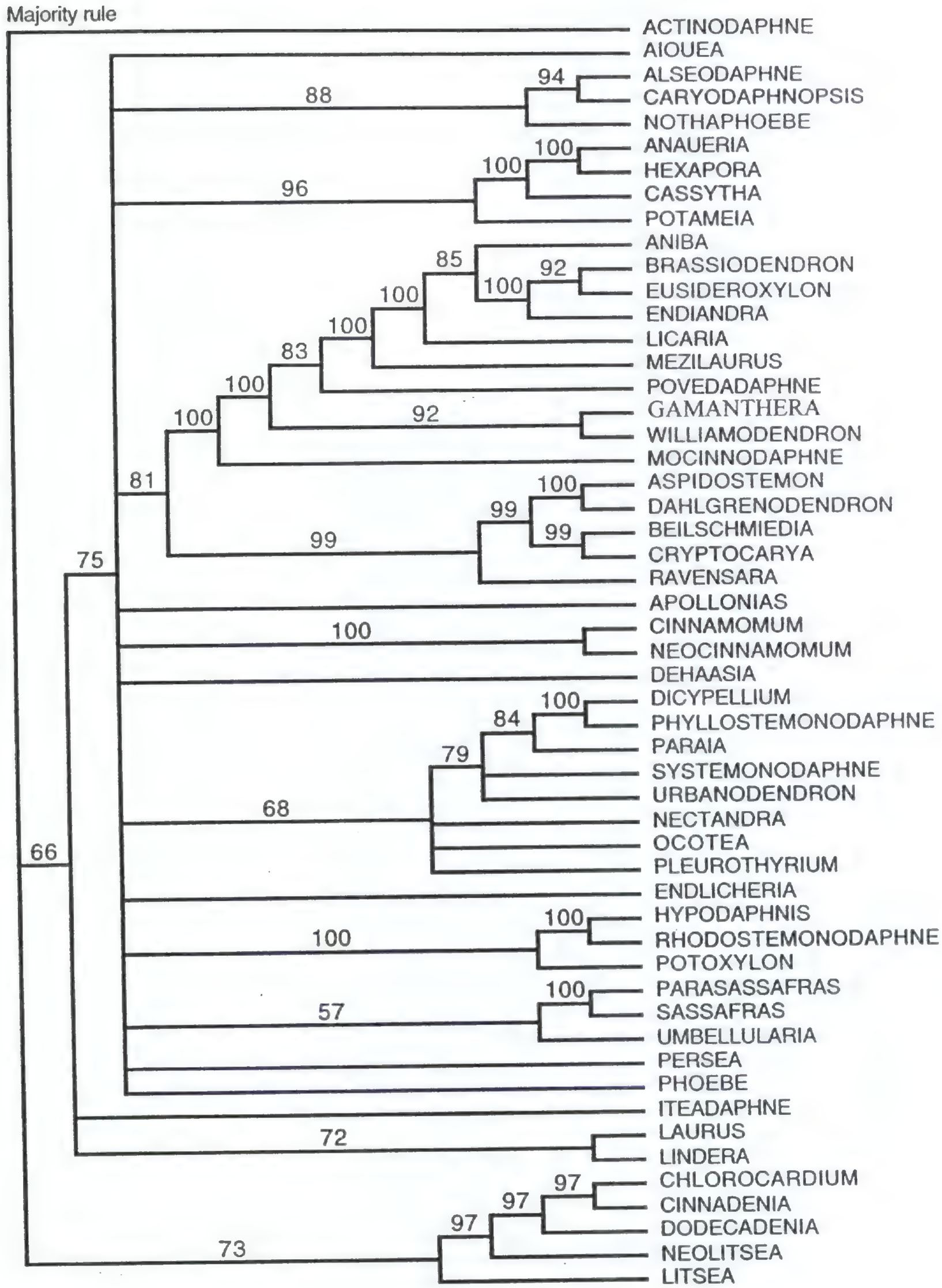


Figure 21. Majority rule consensus cladogram obtained from 32100 equally parsimonious trees (233 steps long) showing relationships among genera of Lauraceae when all character states are coded unordered. C. I. = 0.304

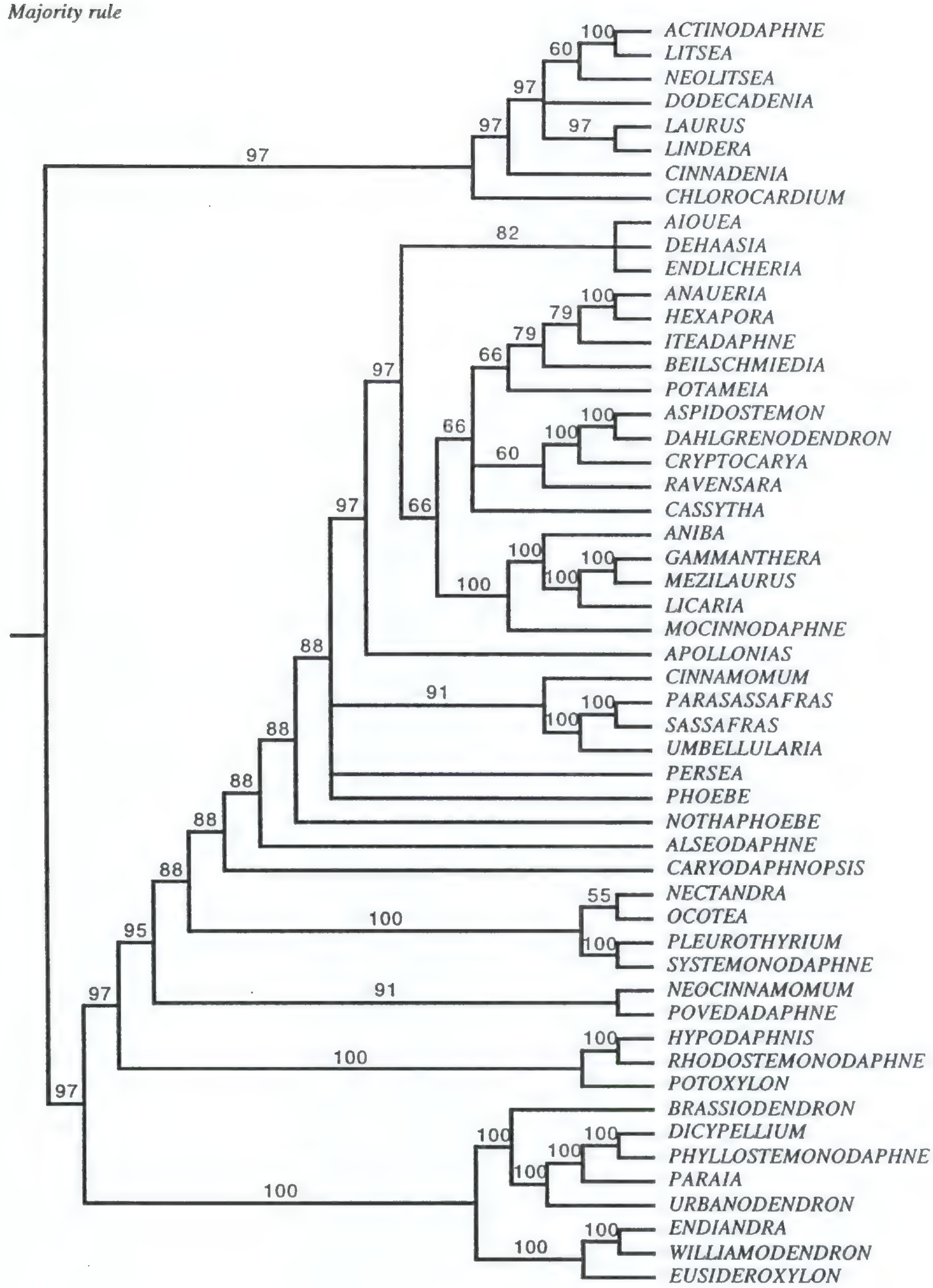


Figure 22. Majority rule consensus cladogram obtained from 2510 equally parsimonious trees (258 steps long) showing relationships among genera of Lauraceae when character states are coded according to suggested evolutionary trends explained in the text. C. I. = 0.870

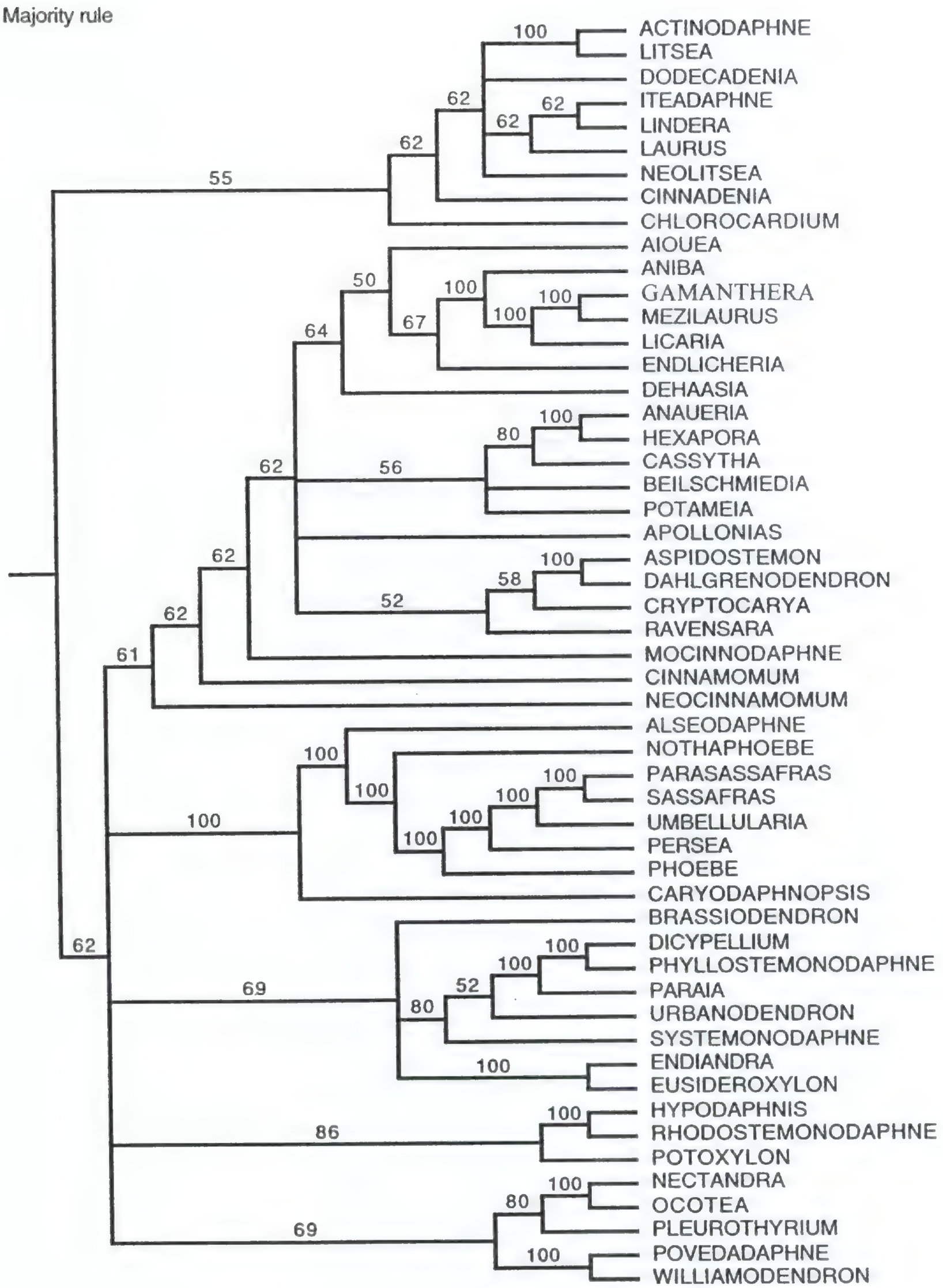


Figure 23. Majority rule consensus cladogram obtained from 2200 equally parsimonious trees (268 steps) showing relationships among genera of Lauraceae when hypothetical ancestor "Archaeodaphne" is incorporated in the analysis. C.I. = 0.611

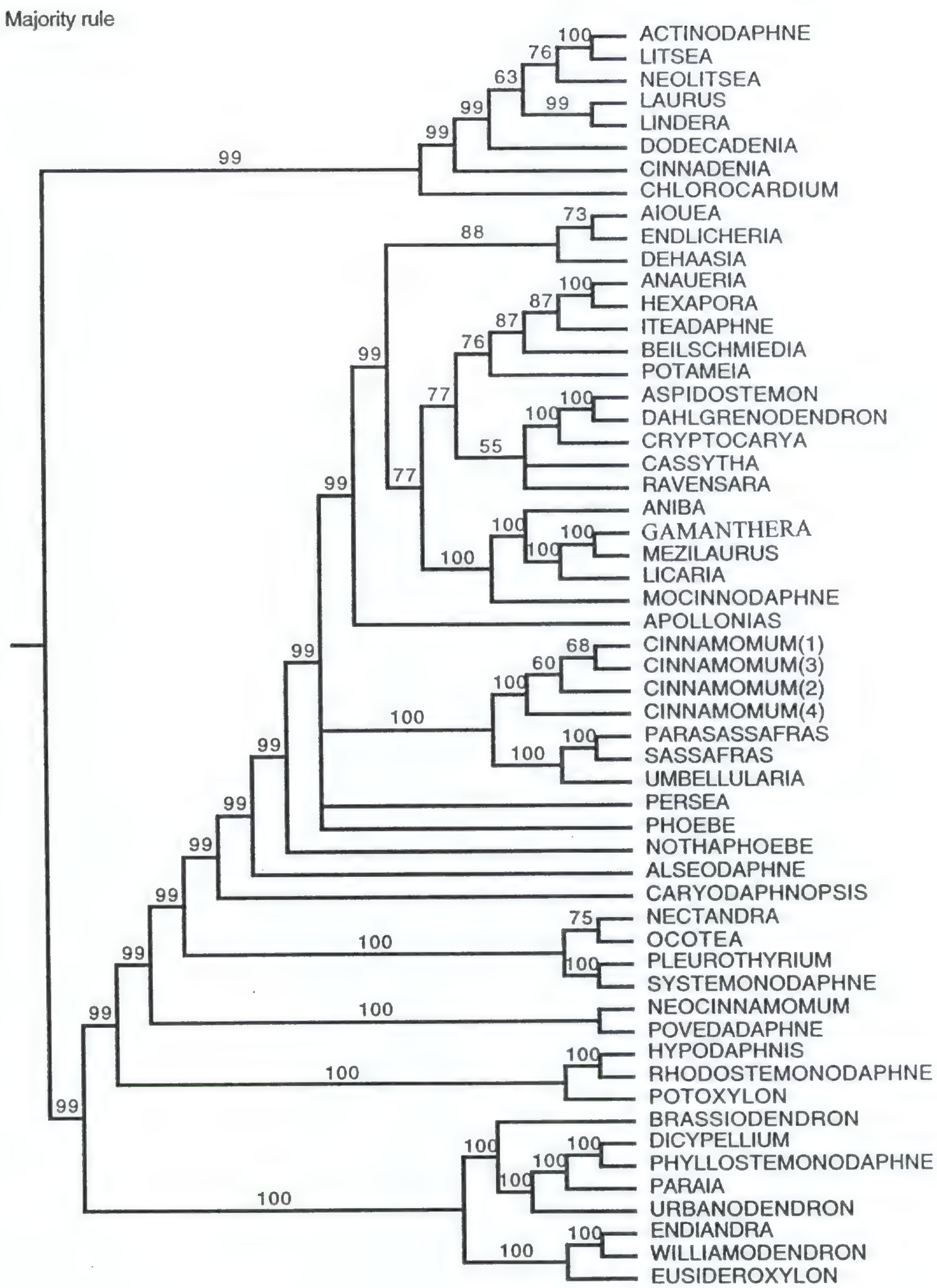


Figure 24. Majority rule consensus cladogram obtained from 2150 equally parsimonious trees (258 steps long) showing relationships among genera of Lauraceae when *Cinnamomum* morphological groups are entered separately in the analysis with character states coded according to evolutionary trends suggested in the text. C. I. = 888

cladograms of two groups of genera (except few taxa) that have been suggested to conform different subfamilies in the Lauraceae. The Laureae, including *Actinodaphne*, *Dodecadenia*, *Neolitsea*, *Litsea*, *Laurus*, *Lindera*, *Sassafras*, *Parasassafras*, and *Umbellularia*; and the Perseae, including the rest of the genera. This point is more apparent in figure 23, where the ancestor was included in the analysis. It is interesting to note in this respect the closeness of the genera *Chlorocardium* and *Cinnadenia* to the genera in the Laureae as well. These genera have been left as of uncertain affinity in Rohwer's taxonomic scheme of the family. Another point to stress is the exclusion of *Parasassafras*, *Sasassafras*, and *Umbellularia* in all cladograms from the Laureae. This is due to the lack of glands in stamen whorls I, II, and IV, and the abscence of supernumerary whorls of stamens, all these characters considered synapomorphies for the Perseae in the analysis.

A second general aspect to comment is the support, at least partially, for some of the subgroups mentioned by Rohwer. Particularly, genera in the Aniba, Beilschmiedia, Cryptocarya, and Mezilaurus subgroups come together or close in the cladograms. This is more evident in the cladogram resulting from the analysis without restrictions (figure 21), and especially the one resulting from incorporating the ancestor (figure 23). It is interesting that some genera from different subgroups result in the same clades suggesting a closer relationship among them, as has been envisaged by Rohwer; e.g. the clade *Anaueria* - *Ravensara* in the cladogram of figure 22, or the clade *Aniba* - *Williamodendron* in figure 21.

On the other hand, the scattered distribution of the genera in the Ocotea and Persea subgroups in the cladograms was something unexpected, for their morphological similarities indicated they are well defined groups. Certainly some pieces of these subgroups are maintained

(like *Persea* - *Phoebe* and *Nectandra* - *Pleurothyrium* - *Ocotea* in figures 21 and 22, or most of the Persea subgroup in figure 23) but mostly they are not. Furthermore, they come out in clades with some genera that stand morphologically far from them, like the clades *Aiouea* - *Dehaasia*, and *Caryodaphnopsis* - *Umbellularia* in figure 22. In general, the cladogram where the ancestor was included is closer to the scheme advanced by Rohwer (1993a).

As for *Cinnamomum*, in two cases (figures 22 and 23) it comes out far from the genera usually considered as its relatives, e.g. *Ocotea*, *Persea*, and *Phoebe* (as has been commented early in this study); in the cladogram obtained where all characters were coded as unordered the relationships of these genera are not resolved (figure 21). In figure 22, *Cinnamomum* places along with some genera usually considered in the Laureae. Here, the characters that hold this group of genera as a clade are the presence of arylpropanoids, and the latrorse dehiscence of inner sporangia in the stamens of whorl III. Another character that is shared by this clade and the terminal nodes *Persea* to *Alseodaphne* is the overlapped position of sporangia in the anthers. In figure 23, *Cinnamomum* comes out as an independent line. In this case, characters that come at the node where *Neocinnamomum* arises and separate the clade *Aiouea* - *Ravensara* are presence of triplinerved leaves, and presence of domatia. Persistent tepals in the fruit is also a trait that supports this part of the cladogram. In the survey of the cladogram in figure 22 using MacClade (Maddison & Maddison, 1992) three apomorphies were found for *Cinnamomum*: 1) opposite leaves, 2) presence of domatia, and 3) perigynous flowers. Except for the last character, no other feature used to distinguish *Cinnamomum* (see table 2) was identified as an apomorphy for this genus.

On the other hand, when the four morphological groups recognized in *Cinnamomum* (1.

section Camphora; 2. section Cinnamomum; 3. neotropical triplinerved; 4. neotropical pinninerved) were separated for the analysis to assess their relationship they came out as a single clade (figure 24). This outcome may strengthen in some way the idea that these four entities currently regarded as pertaining to *Cinnamomum* actually conform a separate evolutionary line within the Lauraceae. Also, it implies that other characters besides the vegetative ones that separate the four groups might be more important to maintain the genus as a unit; that is the case of traits like persistent tepals in the fruit, and perigynous flowers. The closer relationship between *Cinnamomum* (1) and *Cinnamomum* (3) is due to the presence of domatia. The separation of *Cinnamomum* (4) from the rest is because of the presence of opposite strictly triplinerved leaves.

In the end, it is interesting to find that, based on the characters used in this study, *Cinnamomum* can be supported as a distinct phylogenetic line in the Lauraceae. Yet, it will be interesting to see if this preliminary result is maintained when information that was not available now is incorporated; that is the case of, for example, the presence of perulate leaf buds in section Camphora, a feature that is also present in other Asian genera, and the study of arylpropanoids in the neotropical species.

The analysis of Neotropical *Cinnamomum*.

With respect to the analysis of the phylogenetic relationships within the neotropical species of *Cinnamomum*, the situation unfortunately is not much different from what is found at the genus level. Macromorphological characters that can be used without too much ambiguity to study species relationhips are considerably few. Furthermore, characters that can be ordered in a

particular sequence suggesting trends of evolution are even fewer. Originally, it was planned to polarize the traits found in the species using the results from the analysis at the genus level. But given the difficulties found in that search and the diminished power of the outcome, it was decided not to do the polarization in that way.

The attempts of polarizing the characters taking either section of *Cinnamomum* from the Old World as outgroups were not successful since the variation of characters in these sections matched almost completely the variation found in the neotropical species. In addition, the collection of *Cinnamomum* species from Asia at MO is not adequate to survey the variation of all features; because of that the analysis coding all characters unordered was utilized for this purpose. The characters used in this analysis and their states are listed next (the corresponding data matrix for the species is shown in figure 25):

1.) *Twig surface*. **0**, smooth; **1**, ridged; **2**, winged.

2.) *Branch interior*. **0**, solid; **1**, hollow.

3.) *Leaf venation pattern*. **0**, pinninerved; **1**, triplinerved.

4.) *Indument of lower leaf surface*. **0**, straight and appressed; **1**, straight and erect; **2**, wavy to curly; **3**, absent.

5.) *Wax particles on twigs and/or leaf lower surface*. **0**, absent; **1**, present.

6.) *Primary domatia*. **0**, flat; **1**, ampullose; **2**, absent.

7.) *Secondary domatia*. **0**, present; **1**, absent.

8.) *Inflorescence architecture*. **0**, one or two dichasia; **1**, thyrso-paniculate.

9.) *Foliose bracts of the inflorescence*. **0**, present; **1**, absent.

10.) *Hairs on tepal abaxial surface*. **0**, present; **1**, absent.

11.) *Pubescence on adaxial surface of external tepals*. **0**, sericeous; **1**, glabrous.

12.) *Red trichomes on floral structures*. **0**, present; **1**, absent.

13.) *Staminal glands*. **0**, present; **1**, absent.

14.) *Sporangia of stamens of whorl III*. **0**, four; **1**, two.

15.) *Pedicel in fruit*. **0**, partially turbinate; **1**, entirely turbinate.

16.) *Tepals in fruit*. **0**, entirely persistent; **1**, partially persistent; **2**, deciduos.

17.) *Hypanthium interior*. **0**, sericeous; **1**, glabrous.

Figure 26 shows the result of the analysis with all characters unordered. Figure 27 shows the result of setting the change in number of sporangia as irreversible (to root the tree), actually the only character change that could be visualized in a defined evolutionary trend at the species level.

Considering the outcome from both cladograms (figures 26 and 27), it is suggested that the subdivision of the American species into subgenera based on the number of sporangia in the anthers of whorl III may be wrong. Figure 26 shows at least two independent events for the change in this character; from the node where *C. sellowianum* derives up to *C. quadrangulum*, and the clade conformed by *C. heterantherum*, *C. napoense*, and *C. formicarium*. Figure 27 shows at least three different points for the reduction of the number of sporangia in whorl III (see taxa mentioned before). On the other hand, the trend of four to two sporangia has been considered to occur independently in different lines across the family (Rohwer, 1994), a matter which is also appreciated in the surveys attempted here with the genera. Furthermore, the change from four to two sporangia has been recorded also in some Asian species of *Cinnamomum* (Kostermans, 1985). Therefore, the subgenera Heteranthera and Euphoebe created by Mez (1889)

may have to be rejected.

Changes from triplinerved to pinninerved leaves, and from domatia present to absent both are also suggested to have evolved independently in different occasions. At the same time, the presence of straight appressed hairs on lower surface of the leaves, which at some point was thought to define big sections within the neotropical species of *Cinnamomum*, apparently has arisen several times in the history of these species too.

Unfortunately, none of these trends commented above can be assessed entirely since the information regarding the Old World species of *Cinnamomum* is missing in the analysis. First, of course, it has to be resolved whether all these species (neotropical and paleotropical) are indeed congeneric, for the support of a single clade holding all four morphological groups now included in *Cinnamomum* is rather weak. As mentioned early in the introduction, sections recognized in the Old World are separated on the basis of combination of characters that are not present in the American species. In addition to these differences it became apparent during this study, that domatia are absent in the species with strictly triplinerved leaves (section Cinnamomum), but present in those with pinninerved (to subtriplinerved) leaves (section Camphora). In the neotropics the reverse situation is found: species with domatia are those with mostly triplinerved leaves, while species with pinninerved leaves lack domatia. So far there is only one species in the Neotropics that connects the two groups: *C. heterantherum*, which has domatia and pinninerved leaves.

Certainly for the moment it is advisable to keep the group of species studied here along with the Asian species within *Cinnamomum*, since their shared morphological characters fit well the concept of the genus. However, if one wants to represent phylogeny in the classification of

these taxa (and the Lauraceae too), it is necessary to make a large effort to compile enough information suitable for this kind of research.

CINNAMOMUM 1		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	ALAINII	0	0	1	0	0	1	1	0	1	1	0	1	0	0	1	2	0
2	AMOENUM	1	0	1	0	0	1	1	1	0	1	0	1	0	0	0	1	0
3	AMPLEXICAULE	1	0	0	3	0	2	1	1	0	1	0	0	0	0	0	0	0
4	AMPULLACEUM	0	0	1	0	0	1	1	0	1	1	0	1	0	0	0	0	0
5	AREOLATUM	1	0	1	0	0	1	1	1	0	1	0	0	0	0	0	0	0
6	BRACTEFOLIACEUM	1	0	1	2	0	0	0	1	0	0	0	1	0	0	0	0	1
7	BREEDLOVEI	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0
8	BRENESII	0	0	1	2	0	0	1	1	0	0	0	0	0	0	0	1	0
9	CHAVARRIANUM	0	0	0	0	0	2	1	1	1	0	1	0	0	0	1	0	0
10	CHIAPENSE	0	0	0	3	0	2	1	0	1	1	0	0	0	0	0	0	0
11	CONCINNUM	0	0	1	3	0	2	1	0	1	1	0	0	1	0	0	0	0
12	COSTARICANUM	0	0	1	3	0	0	1	1	1	1	0	1	0	0	0	0	1
13	EFFUSUM	0	0	1	0	0	0	0	1	1	1	0	1	0	0	0	0	1
14	ERYTHROPUS	1	0	0	1	0	2	1	1	0	1	0	0	0	1	0	0	0
15	FORMICARIUM	1	1	0	2	1	2	1	1	1	1	1	1	0	1	0	2	0
16	GLAZIOUI	0	0	1	0	0	0	1	1	0	1	0	1	0	0	?	2	0
17	GLOSSOPHYLLUM	0	0	1	2	0	0	0	1	1	0	0	0	0	0	?	0	0
18	GRISEBACHII	0	0	1	3	0	0	1	1	1	1	1	1	0	0	1	0	1
19	HAMMELIANUM	0	0	0	0	0	2	1	1	0	1	1	1	0	0	1	1	1
20	HARTMANII	1	0	0	2	0	0	1	1	1	0	0	0	0	0	0	1	0
21	HATSCHBACHII	0	0	1	0	0	1	1	0	1	0	0	1	0	0	?	2	1
22	HAUSSKNECHTII	0	0	1	2	0	2	1	1	0	1	0	0	0	1	0	1	0
23	HETERANTHERUM	1	0	0	0	0	0	1	1	1	0	0	?	0	1	?	?	0
24	HIRSUTUM	1	0	1	1	0	1	0	1	1	0	0	0	0	0	1	0	0
25	KRUZEANUM	0	0	?	2	0	?	?	1	1	0	?	?	0	0	0	0	?
26	LEPTOPHYLLUM	0	0	1	3	0	0	1	0	1	1	0	0	0	0	0	0	0
27	LONGIPES	2	0	1	0	0	0	1	1	1	1	0	0	0	0	?	0	0
28	NAPOENSE	0	1	0	0	0	2	1	1	1	0	0	1	0	1	0	1	0
29	NEUROPHYLLUM	0	0	1	0	0	0	1	1	1	1	0	1	0	0	1	1	1
30	PACHYPODUM	0	0	1	1	0	2	1	1	1	1	0	0	0	0	0	0	1
31	PADIFORME	0	0	1	1	0	0	0	1	1	0	0	1	0	0	0	0	1
32	PALACIOSII	1	0	1	0	0	0	0	1	1	1	1	0	0	0	?	0	0
33	PARATRIPLINERVE	1	0	1	0	0	0	1	1	0	1	1	1	0	0	1	1	1
34	PSEUDOGLAZIOVII	1	0	1	2	0	0	0	1	1	1	0	1	0	0	0	1	0
35	QUADRANGULUM	2	0	0	3	0	2	1	1	0	1	0	1	0	1	0	0	0
36	RUBRINERVIUM	0	0	1	2	0	2	1	1	0	1	0	0	0	1	?	1	0
37	SALICIFOLIUM	1	0	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0
38	SELLOWIANUM	0	0	1	2	0	0	0	1	0	1	0	0	0	1	0	0	0
39	STENOPHYLLUM	1	0	1	2	0	2	1	1	0	1	0	0	0	1	0	0	0
40	SUBSESSILE	1	0	0	3	0	2	1	1	0	1	0	1	0	1	?	0	1
41	TAUBERTIANUM	0	0	1	2	0	2	1	1	0	1	0	?	0	1	?	0	?
42	TOMENTULOSUM	1	0	1	1	0	2	1	1	0	1	0	0	0	1	0	1	0
43	TONDUZII	1	0	1	2	0	0	0	1	0	0	0	0	0	0	0	1	0
44	TRIPLINERVE	?	0	1	0	0	0	1	1	?	0	0	0	0	0	0	0	0
45	UNINERVIUM	1	0	0	3	0	2	1	1	1	1	0	0	0	0	0	0	1
46	VELVETII	0	0	0	2	1	0	1	1	0	0	0	0	0	0	1	0	1
47	ZAPATAE	0	0	1	2	0	0	0	1	1	0	0	0	0	0	1	0	0

Figure 25. Data matrix used for the phylogenetic analysis of the Neotropical species of the genus *Cinnamomum*.

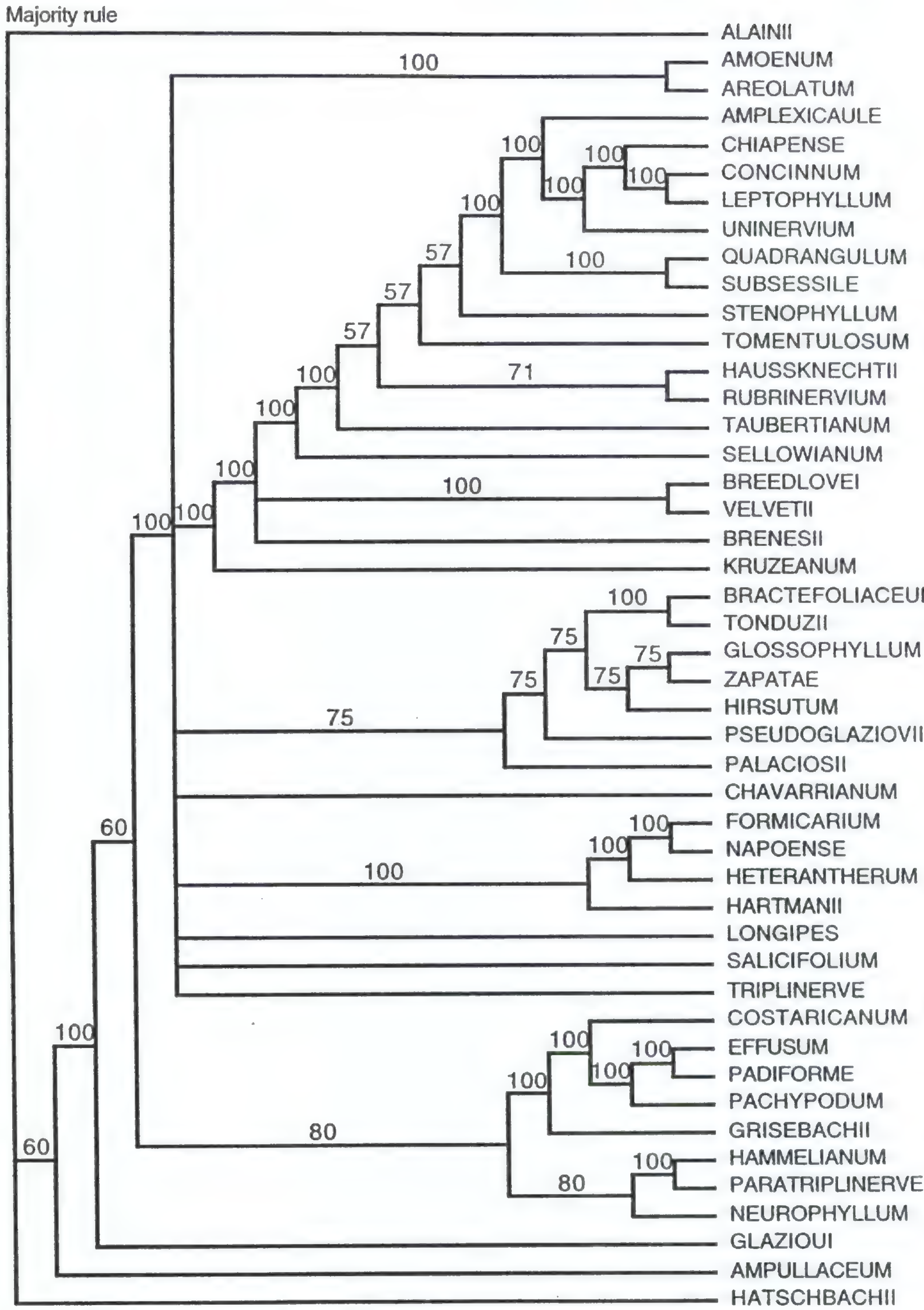


Figure 26. Majority rule consensus cladogram obtained from 280 equally parsimonious tress showing relationships among Neotropical species of *Cinnamomum* when all characters are coded unordered. C. I. = 0.620

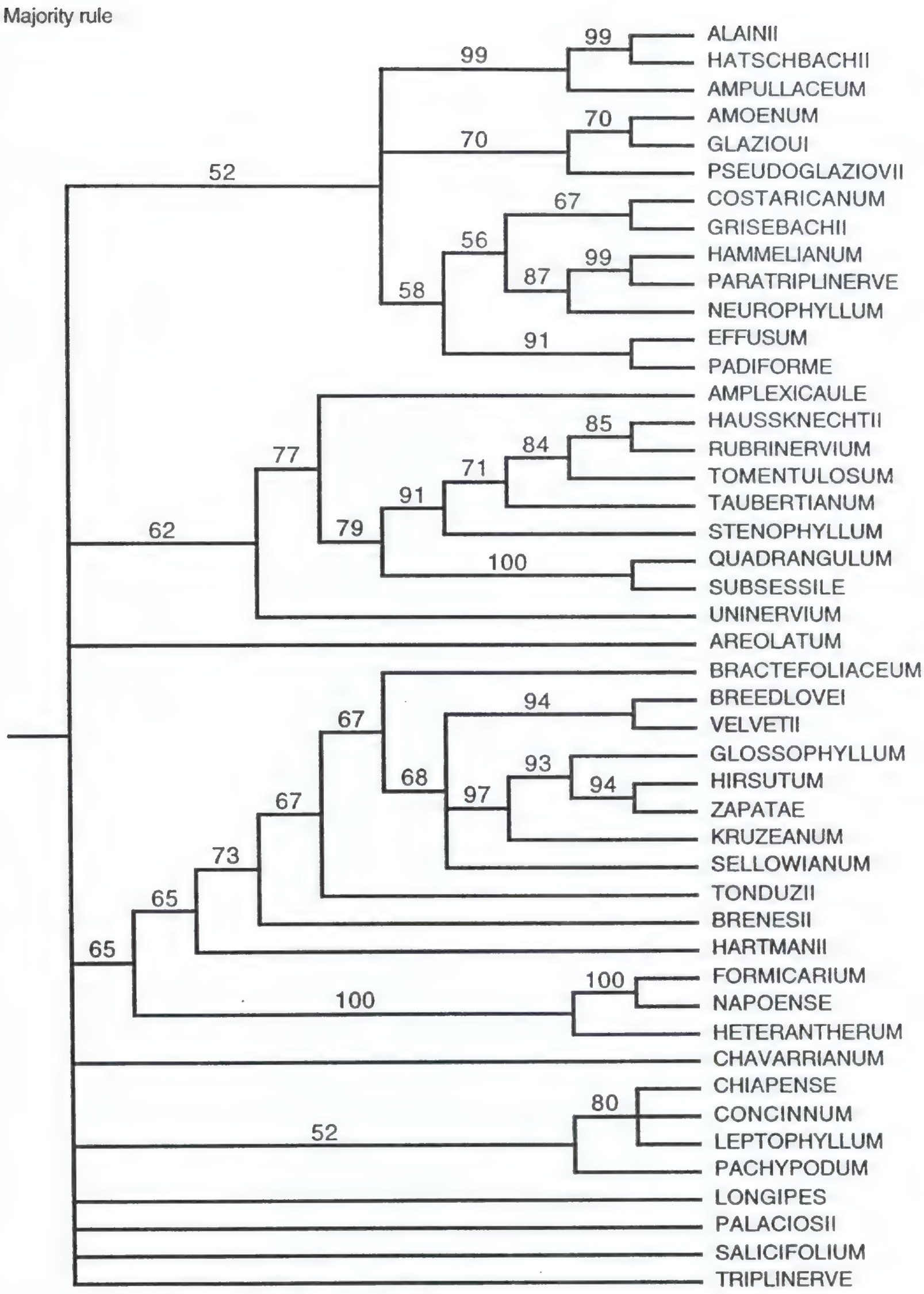


Figure 27. Majority rule consensus cladogram showing relationships among Neotropical species of *Cinnamomum* when change from four to two sporangia in stamens of whorl III is set irreversable.

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Apendix 1. **Species distribution by country**.

Mexico: *C. amplexicaule*, *C. ampullaceum*, *C. areolatum*, *C. bractefoliaceum*, *C. breedlovei*, *C. chiapense*, *C. concinnum*, *C. effusum*, *C. glossophyllum*, *C. grisebachii*, *C. hartmanii*, *C. kruseanum*, *C. leptophyllum*, *C. longipes*, *C. pachypodum*, *C. padiforme*, *C. salicifolium*, *C. velvetii*, *C. zapatae*.

Belize: *C. triplinerve*.

Guatemala: *C. padiforme*, *C. triplinerve*, *C. zapatae*.

Honduras: *C. neurophyllum*, *C. padiforme*, *C. triplinerve*.

El Salvador: *C. areolatum*, *C. triplinerve*.

Nicaragua: *C. costaricanum*, *C. padiforme*, *C. triplinerve*.

Costa Rica: *C. brenesii*, *C. chavarrianum*, *C. costaricanum*, *C. hammelianum*, *C. neurophyllum*, *C. paratriplinerve*, *C. tonduzii*, *C. triplinerve*.

Panama: *C. brenesii*, *C. costaricanum*, *C. hammelianum*, *C. paratriplinerve*, *C. tonduzii*, *C. triplinerve*.

Cuba: *C. grisebachii*, *C. triplinerve*.

Hispaniola: *C. alainii*, *C. grisebachii*, *C. triplinerve*.

Puerto Rico: *C. triplinerve*.

Lesser Antilles: *C. triplinerve*.

Colombia: *C. triplinerve*.

Venezuela: *C. triplinerve*.

Ecuador: *C. formicarium*, *C. napoense*, *C. palaciosii*, *C. triplinerve*.

Peru: *C. heterantherum*, *C. subsessile*, *C. triplinerve*.

Bolivia: *C. triplinerve*.

Paraguay: *C. triplinerve*.

Argentina: *C. amoenum*.

Uruguay: *C. amoenum*, *C. triplinerve*.

Brazil: *C. amoenum*, *C. erythropus*, *C. glaziovii*, *C. hatschbachii*, *C. haussknechtii*, *C. hirsutum*, *C. pseudoglaziovii*, *C. quadrangulum*, *C. rubrinervium*, *C. sellowianum*, *C. stenophyllum*, *C. taubertianum*, *C. tomentulosum*, *C. triplinerve*, *C. uninervium*.

Guyana: *C. triplinerve*.

Surinam: *C. triplinerve*.